Appendix E1 – Restoration Plans and TMDLs (Watershed Assessments)

Watershed Assessments Master Plan

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TECHNICAL MEMORANDUM

TO: Ms. Michele Dobson
Project Manager, Harford County Department of Public Works

FROM: Ms. Sanita Corum, EA Project Manager

DATE: 21 December 2017

SUBJECT: Watershed Assessment Master Plan – Subwatershed Desktop Analysis

INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA), on behalf of the Harford County Government Department of Public Works (the County), has prepared this Technical Memorandum (Memorandum) to describe the methodology used to conduct a geographic information system (GIS) desktop analysis of the County's subwatersheds and assign a priority ranking for future watershed assessments efforts.

This Memorandum provides an overview of the desktop analysis, including maps and summary tables presenting relevant GIS layers used in the desktop analysis.

BACKGROUND

During the permit cycle, the County is required to complete small watershed assessments (subwatersheds), in order to provide sufficient opportunities to meet the restoration requirements established within the current National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit[1].

The County is developing a watershed restoration master plan for the entire county for each 8-digit watershed. "The watershed restoration master plan will provide a broad characterization for each watershed based on a GIS desktop analysis and a schedule for conducting small watershed assessments. The schedule will focus on conducting small watershed assessments with the anticipation that restoration implementation will begin within three years." (Harford County 2016). The following subwatershed assessments have been completed by the County: Wheel Creek (2008), Plumtree Run (2011), Sam's Branch (2012), Foster Branch, and Declaration Run and Riverside Area (2014).

[1] The Harford County NPDES permit was issued by the Maryland Department of the Environment (MDE) with permit number 11-DP-3310 MD0068268, effective dates 30 December 2014 to 29 December 2019.

DESKTOP ANALYSIS

EA and the County worked together to select from the list of potential metrics to be used for the desktop analysis of the County's subwatersheds and assign a priority ranking for future watershed assessment efforts. The desktop analysis was performed using the following GIS data layers provided by the County:

- Watershed and subwatershed boundaries
- Impervious cover
- Completed subwatershed assessments
- Watersheds with Total Maximum Daily Loads (TMDLs)
- Development envelope
- Land use/land cover.

METHODOLOGY AND RESULTS

Results of the desktop analysis were compiled and the results were analyzed to prioritize the subwatersheds for future watershed assessment opportunities. The results of the desktop analysis are included in maps (Figures 1 – 4), and summary tables (Tables 1 – 5). EA used ESRI ArcGIS data provided by the County in conjunction with the associated program, ArcMap 10.4.1 to perform the desktop analysis.

Watershed and Subwatershed Boundaries

The watershed and subwatershed boundaries and acreage falling under the County's jurisdiction were included in the desktop analysis. There are 13 watersheds (Figure 2, Table 2) in Harford County. There are 121 subwatersheds included in the desktop analysis (Figure 1; Table 1). The feature class attributes presented in Table 1 include Feature ID, Maryland (MD) 8-Digit Watershed ID and Name, and subwatershed, subwatershed acreage, subwatershed impervious acreage and percent impervious cover. The Feature IDs are also presented on Figure 5.

Impervious cover

The County's impervious cover data layer was used to derive the percentage of impervious cover for watersheds and subwatersheds within the County boundaries. The percent impervious land cover per watershed and subwatershed was divided into five distinct categories based upon the ArcGIS quantile classification. Subwatershed impervious cover percentages range from approximately 0 to 22 percent of the subwatershed area (11,506 acres). The calculated percentage of impervious land cover per subwatershed is shown on Figure 1 and Table 1. The highest percent impervious cover by subwatershed is located in the south end of the County within the development envelope. The calculated percentage of impervious land cover per watershed is shown on Figures 2 and 3, and Table 2. Overall, impervious surfaces cover approximately 72 percent of the watershed acreage (494,620 acres), as determined by the 2000

data layer used in the desktop analysis. The highest percent impervious cover by watershed is located in the Bynum Run, Gunpowder River and, Lower Winters Run watersheds.

Completed Subwatershed Assessments

The County has completed the following subwatershed assessments: Wheel Creek, Plumtree Run, Sam's Branch, Foster Branch, and Declaration Run and Riverside Area. The impervious coverage and acreages of these completed subwatersheds—shown on Figures 1, 2, and 3—were included in the desktop analysis and subwatershed prioritization.

Watersheds with Total Maximum Daily Loads (TMDLs)

The County has four watersheds with approved TMDLs (Bush River, Bynum Run, Swan Creek, and Loch Raven Reservoir). The impervious coverage and acreages of these watersheds with approved TMDLs—shown on Figure 3 and Table 3—were included in the desktop analysis and subwatershed prioritization.

Development Envelope

The original objective of the development envelope was to concentrate development in a specific area of the County that was appropriately zoned and had adequate public facilities and resources to sustain a growing population, while in theory reducing the amount of uncontrolled growth outside of the development envelope. The current development envelope includes approximately 56,600 acres. The impervious coverage and acreages of the development envelope—shown on Figures 2 and 4—were included in the desktop analysis and subwatershed prioritization.

Land Use/Land Cover

The land use/land cover layers were developed based on the 2004 land use survey. The following land use classifications were used: Agriculture, Barren Land, Forest, Transportation, Urban Land Use, Water and Wetlands. A map of land use/land cover is provided as Figure 4. A summary of the land use/land cover percentages by subwatershed is presented in Table 4. The majority of the County's land use/land cover is comprised of forest, agriculture, and urban land use.

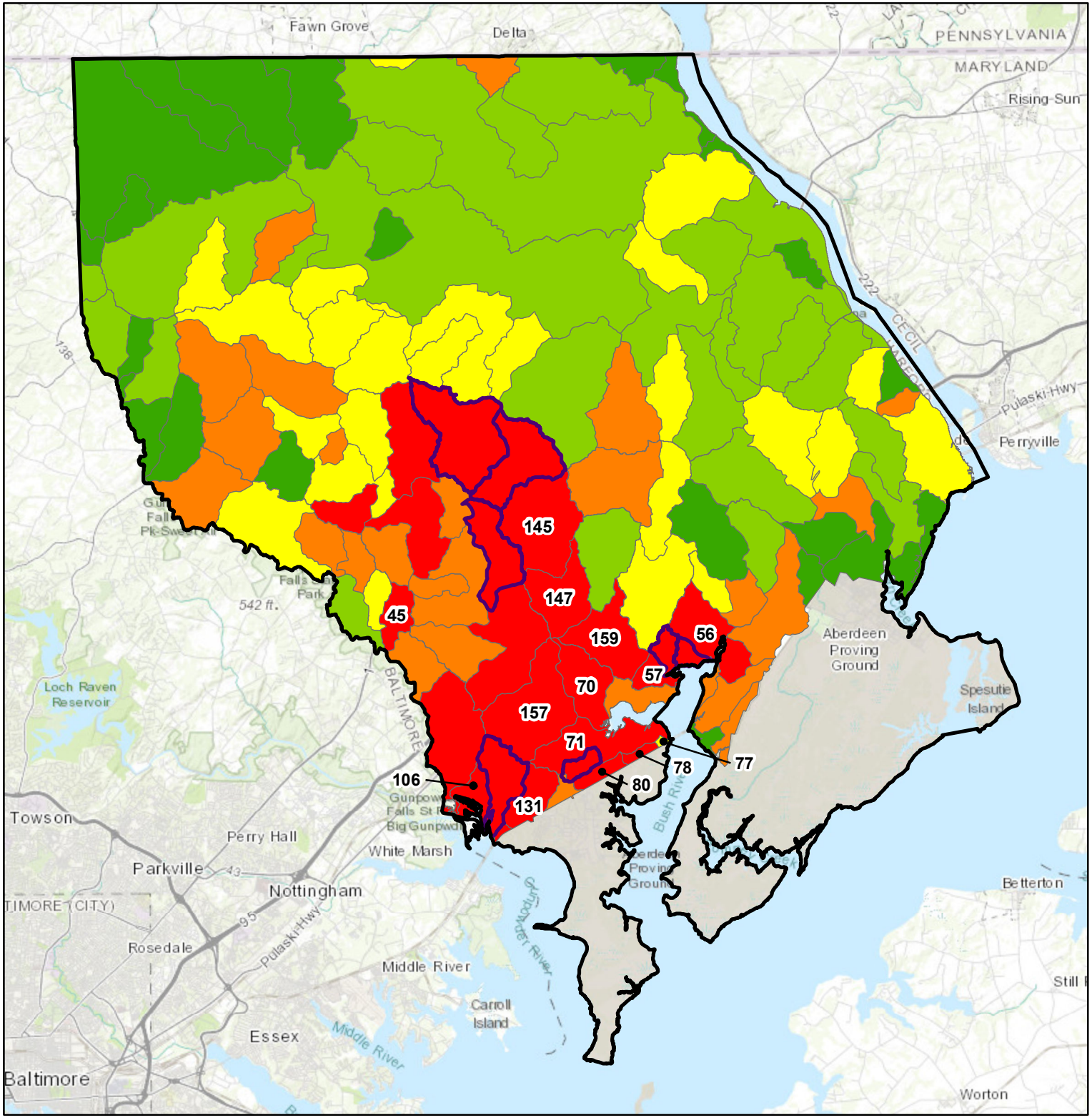
SUBWATERSHED PRIORITIZATION

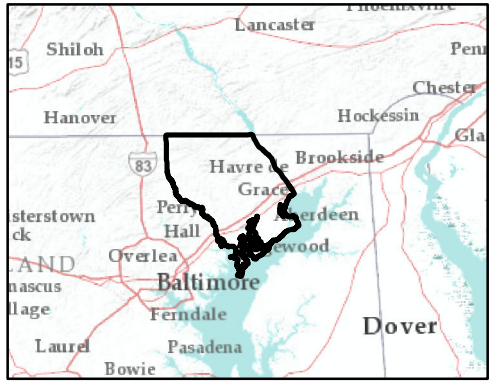
During the desktop analysis, subwatersheds with the highest percent impervious cover were ranked. Subwatersheds with higher percentages of impervious cover indicate higher priorities for restoration opportunities. These subwatersheds were then prioritized based on percent impervious cover, opportunities for combining subwatersheds and restoration efforts, and watershed TMDLs. The 10 highest ranked subwatersheds selected as a result of the desktop analysis are included in Table 5. These subwatersheds are included in the Bush River, Gunpowder River and, Lower Winters Run watersheds.

REFERENCES

Harford County. 2016. Harford County, Maryland Department of Public Works Watershed Protection and Restoration Office 2016 Annual MS4 Report. December.

FIGURES





Legend

- Harford County
- Completed Subwatershed Assessments

Percent Impervious

- 0.00% - 2.27%
- 2.28% - 3.08%
- 3.09% - 4.38%
- 4.39% - 8.68%
- 8.69% - 22.15%

Total Impervious Area*

11,506.31 acres

Total Percent Impervious*

4.74%

0 1.75 3.5 7 Miles

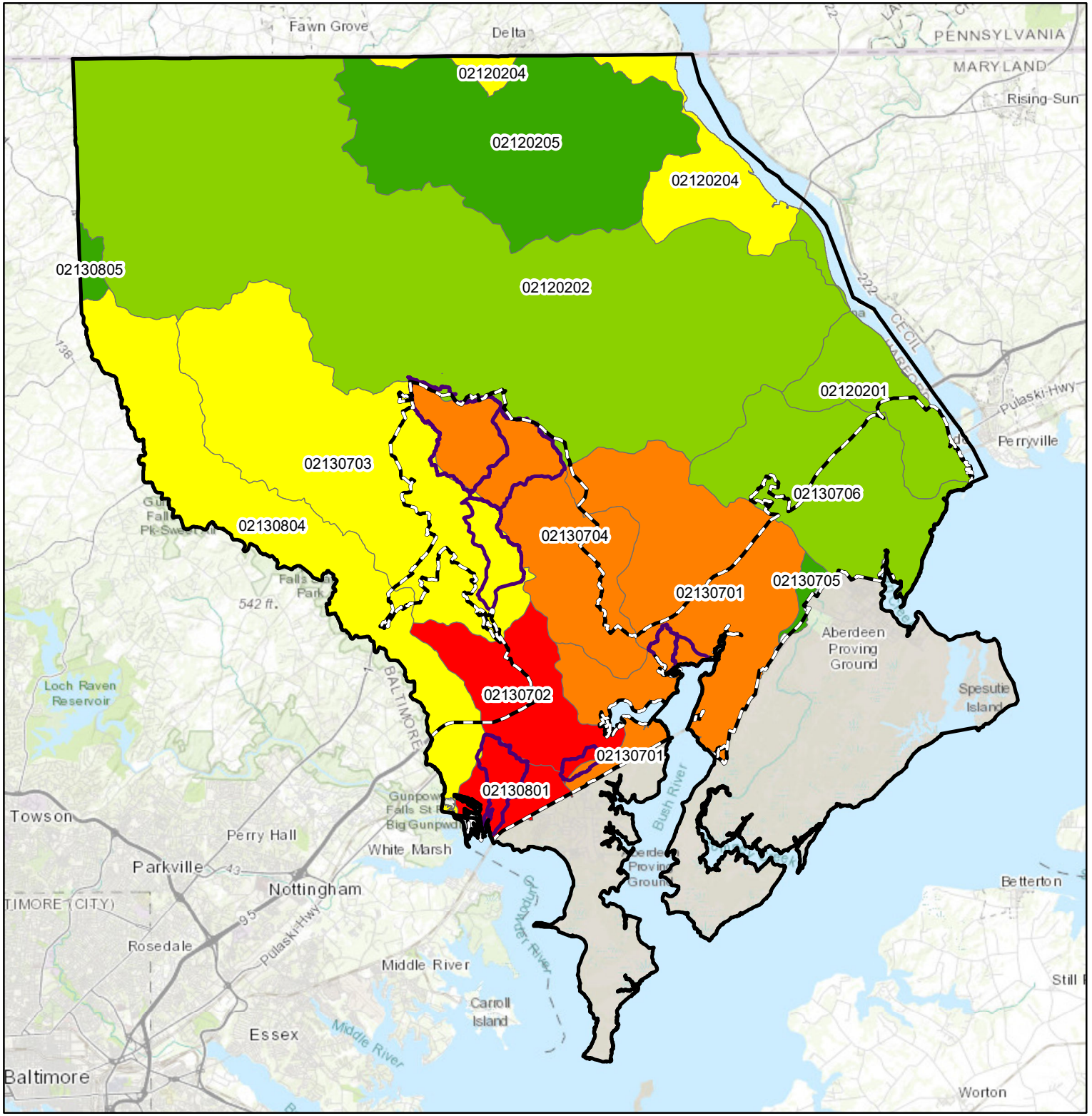
Date: 12/13/2017

Basemap: ESRI 2016

Figure 1

Harford County Percent Impervious Cover by Subwatershed

*Impervious area calculations based on 2000 impervious cover survey.



Legend

- Harford County
- Development Envelope
- Completed Subwatershed Assessments

Percent Impervious

- 0.01% - 2.54%
- 2.55% - 3.21%
- 3.22% - 6.48%
- 6.49% - 11.05%
- 11.06% - 13.45%

Total Impervious Area*

11,506.31 acres

Total Percent Impervious*

4.74%

0 1.75 3.5 7 Miles

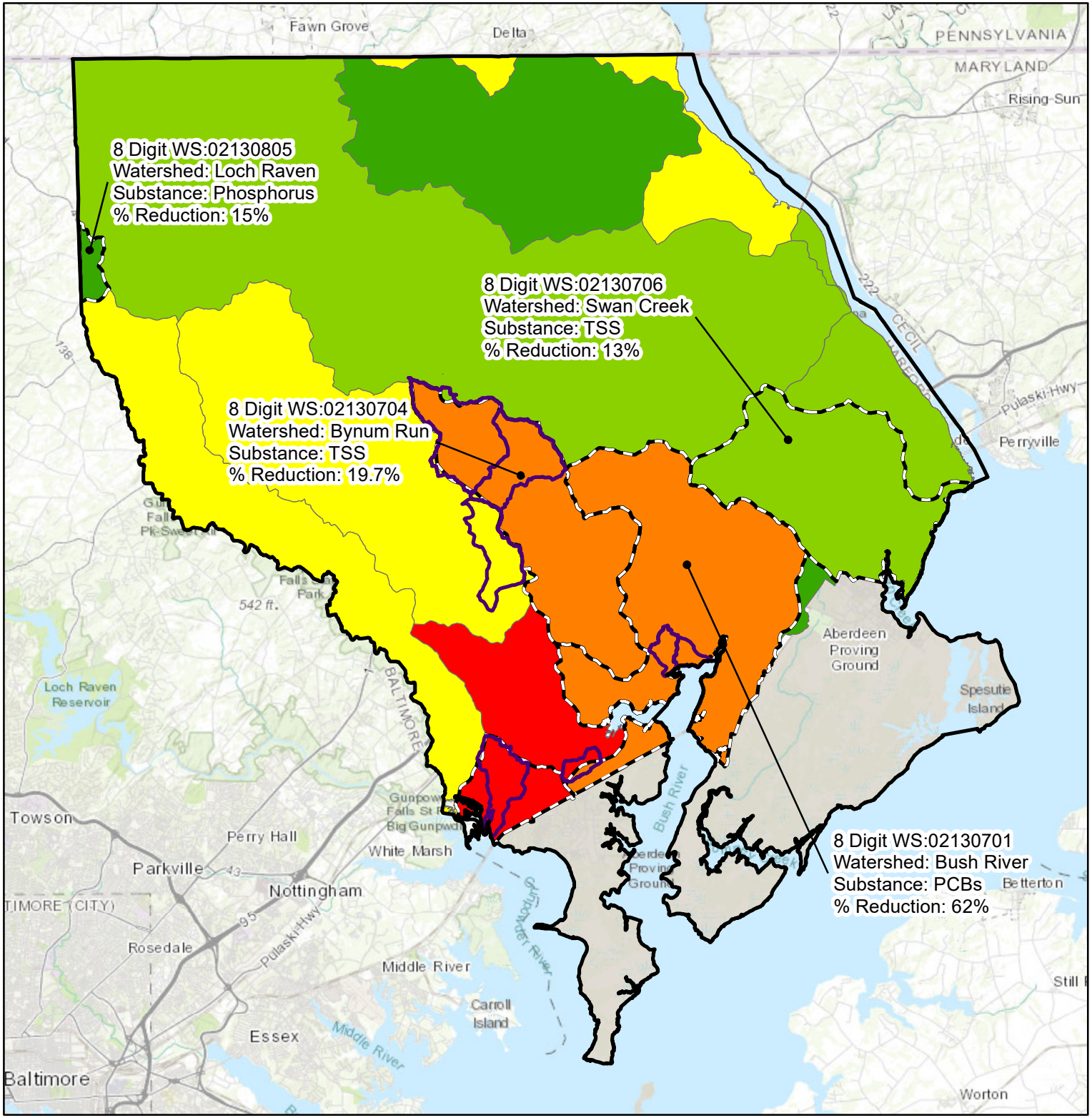
Date: 12/13/2017

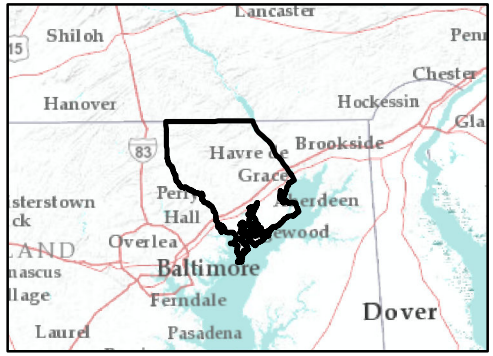
Basemap: ESRI 2016

Figure 2

Harford County Percent Impervious Cover by 8-digit Watershed

*Impervious area calculations based on 2000 impervious cover survey.





Legend

- Harford County
- Completed Subwatershed Assessments
- Watersheds with TMDLs

Percent Impervious

- 0.01% - 2.54%
- 2.55% - 3.21%
- 3.22% - 6.48%
- 6.49% - 11.05%
- 11.06% - 13.45%

Total Impervious Area*

11,506.31 acres

Total Percent Impervious*

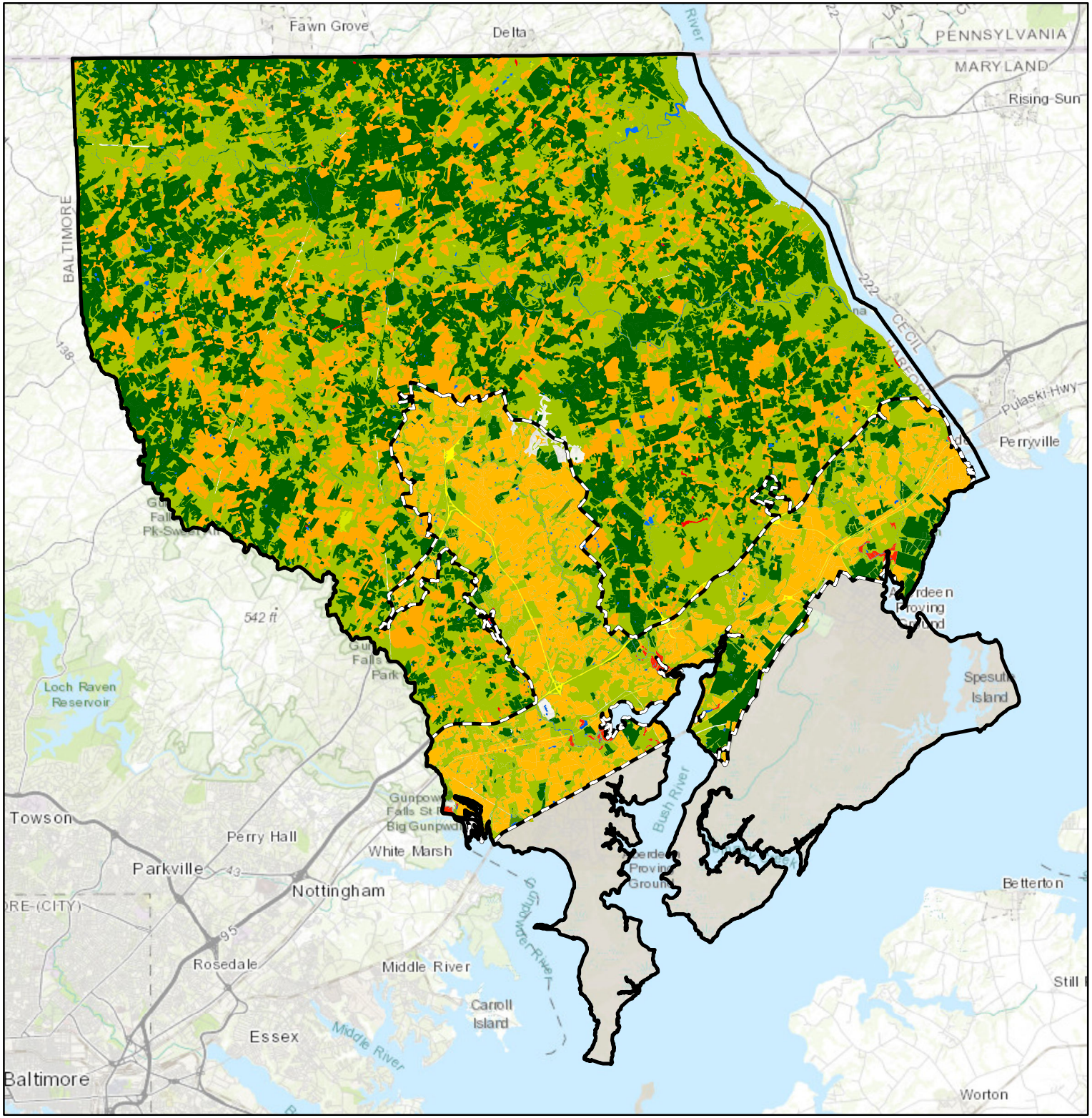
4.74%

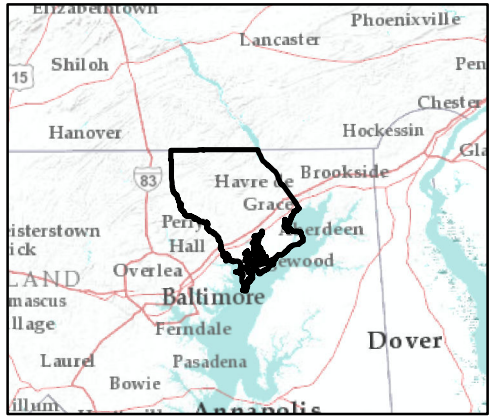
0 1.75 3.5 7 Miles

Date: 12/13/2017
Basemap: ESRI 2016

Figure 3
Harford County TMDL Allocations by 8-digit Watershed

*Impervious area calculations based on 2000 impervious cover survey.





Legend

- Harford County
- Development Envelope

Land Use Classification

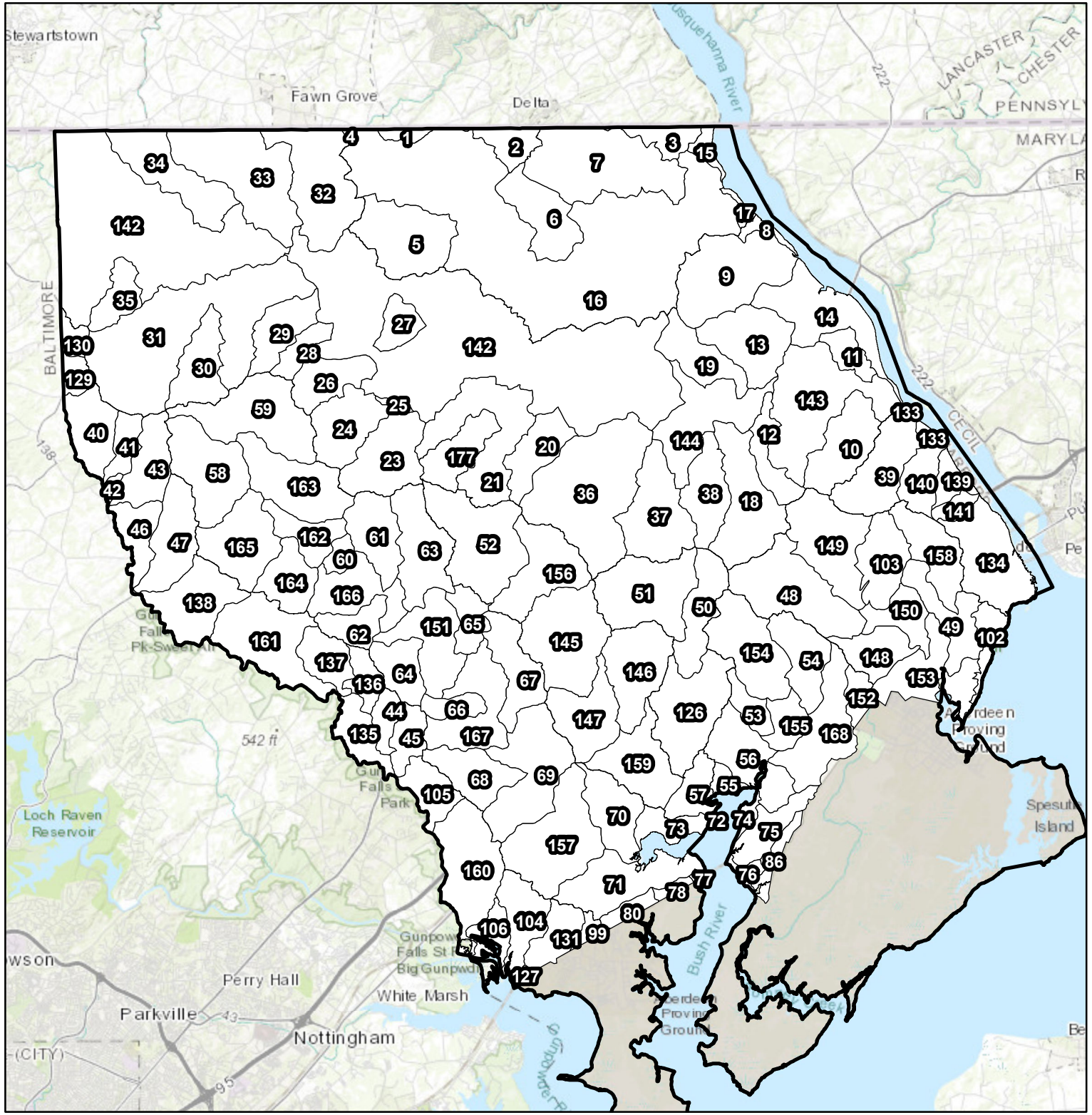
- Not Classified
- Agriculture
- Barren Land
- Forest
- Transportation
- Urban Land Use
- Water
- Wetlands

0 1.75 3.5 7 Miles

Date: 7/31/2017
Basemap: ESRI 2016

Figure 4
Harford County Land Use Classification

*Land use classification based on 2004 land use survey.



Legend

- Harford County
- Subwatersheds

0 1.75 3.5 7 Miles

Date: 7/17/2017
Basemap: ESRI 2016

Figure 5
Harford County Subwatershed Identification

TABLES

Table 1
Summary of Harford County Subwatersheds and Impervious Cover

Feature ID	MD 8-Digit Watershed	MD 8-Digit Watershed Name	Watershed	Subwatershed	Subwatershed Area (Acres)	Subwatershed Impervious Area (Acres)	Percent Impervious
1	02120204	Conowingo Dam-Susquehanna River	Fishing Creek	Fishing Creek	240	10.1	4.18%
2	02120204	Conowingo Dam-Susquehanna River	Scott Creek	Scott Creek	786	55.7	7.09%
3	02120204	Conowingo Dam-Susquehanna River	Michael Run	Michael Run	673	12.0	1.78%
4	02120202	Deer Creek	Neill Run	Neill Run	0.0	0.0	0.00%
5	02120205	Broad Creek	Jacks Hole	Jacks Hole	2,621	75.3	2.87%
6	02120205	Broad Creek	Carr Run	Carr Run	1,851	46.8	2.53%
7	02120205	Broad Creek	Deep Creek	Deep Creek	4,026	110	2.72%
8	02120204	Conowingo Dam-Susquehanna River	Lower Susquehanna	Lower Susquehanna	248	4.2	1.68%
9	02120204	Conowingo Dam-Susquehanna River	Peddler Run	Peddler Run	3,386	119	3.50%
10	02120202	Deer Creek	Elbow Branch	Elbow Branch	1,961	47.5	2.42%
11	02120202	Deer Creek	Buck Branch	Buck Branch	676	15.3	2.27%
12	02120202	Deer Creek	Graveyard Creek	Graveyard Creek	1,052	32.3	3.07%
13	02120202	Deer Creek	Hollands Branch	Hollands Branch	2,187	52.5	2.40%
14	02120204	Conowingo Dam-Susquehanna River	Lower Susquehanna	Lower Susquehanna	2,555	70.0	2.74%
15	02120204	Conowingo Dam-Susquehanna River	Lower Susquehanna	Lower Susquehanna	327	4.7	1.44%
16	02120205	Broad Creek	Broad Creek	Broad Creek	16,896	413	2.45%
17	02120204	Conowingo Dam-Susquehanna River	Lower Susquehanna	Lower Susquehanna	174	3.2	1.86%
18	02120202	Deer Creek	Mill Brook	Mill Brook	2,785	75.3	2.70%
19	02120202	Deer Creek	Hopkins Branch	Hopkins Branch	1,456	59.5	4.09%
20	02120202	Deer Creek	Saint Omer Branch	Saint Omer Branch	1,403	47.9	3.42%
21	02120202	Deer Creek	Stout Bottle Branch	Stout Bottle Branch	3,179	118	3.72%
23	02120202	Deer Creek	Stirrup Run	South Stirrup Run	2,210	74.2	3.36%
24	02120202	Deer Creek	Stirrup Run	North Stirrup Run	1,851	59.5	3.22%
25	02120202	Deer Creek	Stirrup Run	Stirrup Run	120	3.9	3.24%
26	02120202	Deer Creek	Kellogg Branch	Kellogg Branch	1,349	46.1	3.42%
27	02120202	Deer Creek	Gladden Branch	Gladden Branch	754	10.8	1.44%
28	02120202	Deer Creek	Wet Stone Branch	Wet Stone Branch	673	16.2	2.41%
29	02120202	Deer Creek	Rock Hollow Branch	Rock Hollow Branch	1,385	61.0	4.41%
30	02120202	Deer Creek	Little Deer Creek	Cattail Branch	1,604	57.7	3.60%
31	02120202	Deer Creek	Little Deer Creek	Little Deer Creek	7,376	178	2.42%
32	02120202	Deer Creek	Falling Branch	Falling Branch	3,140	56.6	1.80%
33	02120202	Deer Creek	Big Branch	Big Branch	3,717	79.3	2.13%
34	02120202	Deer Creek	Island Branch	Island Branch	2,325	44.1	1.90%
35	02120202	Deer Creek	Jackson Branch	Jackson Branch	955	21.3	2.23%
36	02120202	Deer Creek	Thomas Run	Thomas Run	5,283	160	3.02%
37	02120202	Deer Creek	Tobacco Run	Tobacco Run	2,536	154	6.05%
38	02120202	Deer Creek	Coolbranch Run	Coolbranch Run	1,593	58.7	3.68%
39	02120201	Lower Susquehanna River	Rock Run	Rock Run	2,151	66.3	3.08%
40	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Little Gunpowder Falls	1,506	36.3	2.41%
41	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Thornton Branch	692	15.2	2.20%
42	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Little Gunpowder Falls	119	0.6	0.50%

Table 1
Summary of Harford County Subwatersheds and Impervious Cover

Feature ID	MD 8-Digit Watershed	MD 8-Digit Watershed Name	Watershed	Subwatershed	Subwatershed Area (Acres)	Subwatershed Impervious Area (Acres)	Percent Impervious
43	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Moy Burn	1,525	39	2.57%
44	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Wildcat Branch	587	21.3	3.64%
45	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Wildcat Branch	816	106.2	13.03%
46	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Little Gunpowder Falls	1,098	18.3	1.67%
47	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Yellow Branch	1,871	41	2.21%
48	02130706	Swan Creek	Carsins Run	Carsins Run	3,152	81.9	2.60%
49	02130706	Swan Creek	Gasheys Creek	Gasheys Creek	1,512	44.4	2.94%
50	02130701	Bush River	James Run	James Run	1,608	50.3	3.13%
51	02130701	Bush River	James Run	Broad Run	2,846	135	4.73%
52*	02130704	Bynum Run	Bynum Run	Bynum Run	3,262	429.9	13.18%
53	02130701	Bush River	Grays Run	Grays Run	632	24	3.73%
54	02130701	Bush River	Cranberry Run	Cranberry Run	1,567	45	2.85%
55*	02130701	Bush River	Bush River	Bush River	314	63	19.98%
56	02130701	Bush River	Church Creek	Church Creek	1,977	251.2	12.71%
57*	02130701	Bush River	Bush Creek	Bush Creek	924	122.0	13.20%
58	02130703	Atkisson Reservoir	Winters Run	West Branch	2,567	117.6	4.58%
59	02130703	Atkisson Reservoir	Winters Run	East Branch	3,012	125.5	4.17%
60	02130703	Atkisson Reservoir	Winters Run	Hoops Branch	359	30.1	8.37%
61	02130703	Atkisson Reservoir	Winters Run	Long Branch	1,599	54.9	3.43%
62	02130703	Atkisson Reservoir	Winters Run	Bread And Cheese Branch	921	80.4	8.73%
63	02130703	Atkisson Reservoir	Winters Run	Bear Cabin Branch	2,209	227.4	10.29%
64	02130703	Atkisson Reservoir	Winters Run	Elbow Brook	1,131	63.6	5.62%
65	02130703	Atkisson Reservoir	Winters Run	Heavenly Waters	850	44.8	5.27%
66	02130703	Atkisson Reservoir	Winters Run	High Bridge Branch	563	48.9	8.68%
67*	02130703	Atkisson Reservoir	Winters Run	Plumtree Run	1,664	170.7	10.26%
68	02130702	Lower Winters Run	Winters Run	Mountain Branch	1,509	82	5.41%
69	02130702	Lower Winters Run	Winters Run	Winters Run	3,055	275.9	9.03%
70	02130701	Bush River	Haha Branch	Haha Branch	1,597	188.7	11.82%
71**	02130702	Lower Winters Run	Otter Point Creek	Otter Point Creek	2,295	337.6	14.71%
72	02130701	Bush River	Bush River	Bush River	19	4	20.40%
73	02130701	Bush River	Otter Point Creek	Otter Point Creek	773	49.7	6.43%
74	02130701	Bush River	Bush River	Bush River	211	17.9	8.47%
75	02130701	Bush River	Deep Spring Branch	Deep Spring Branch	1,089	55.2	5.07%
76	02130701	Bush River	Bush River	Bush River	243	2.3	0.94%
77	02130701	Bush River	Bush River	Bush River	50	1.8	3.54%
78	02130701	Bush River	Monks Creek	Monks Creek	177	19	10.68%
80**	02130701	Bush River	Lauderick Creek	Lauderick Creek	400	56	14.04%
86	02130701	Bush River	Sod Run	Sod Run	507	39.7	7.83%
99**	02130801	Gunpowder River	Canal Creek	Canal Creek	258	18.8	7.29%
102	02130706	Swan Creek	Upper Western Shore	Upper Western Shore	678	7.7	1.14%
103	02130706	Swan Creek	Swan Creek	Swan Creek	1,605	52	3.27%

Table 1
Summary of Harford County Subwatersheds and Impervious Cover

Feature ID	MD 8-Digit Watershed	MD 8-Digit Watershed Name	Watershed	Subwatershed	Subwatershed Area (Acres)	Subwatershed Impervious Area (Acres)	Percent Impervious
104*	02130801	Gunpowder River	Foster Branch	Foster Branch	1,421	170	11.94%
105	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Little Gunpowder Falls	1,080	61	5.61%
106	02130801	Gunpowder River	Gunpowder Falls	Gunpowder Falls	673	149	22.15%
126	02130701	Bush River	James Run	James Run	2,796	91.2	3.26%
127	02130801	Gunpowder River	Gunpowder River	Gunpowder River	71	9.4	13.26%
128	02130801	Gunpowder River	Gunpowder Falls	Gunpowder Falls	0.0	0.0	0.00%
129	02130805	Loch Raven Reservoir	Little Falls	First Mine Branch	442	10.2	2.31%
130	02130805	Loch Raven Reservoir	Little Falls	Second Mine Branch	377	6.2	1.63%
131	02130801	Gunpowder River	Reardon Inlet	Reardon Inlet	1,018	122	11.95%
133	02120201	Lower Susquehanna River	Lower Susquehanna	Lower Susquehanna	222	5.5	2.50%
134	02120201	Lower Susquehanna River	Lower Susquehanna	Lower Susquehanna	2,570	84.2	3.28%
135	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Little Gunpowder Falls	1,062	31.5	2.97%
136	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Overshot Branch	697	42.7	6.12%
137	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Overshot Branch	1,060	66.0	6.23%
138	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Little Gunpowder Falls	2,156	128	5.92%
139	02120201	Lower Susquehanna River	Lower Susquehanna	Lower Susquehanna	548	6.9	1.25%
140	02120201	Lower Susquehanna River	Herring Run	Herring Run	954	37.9	3.97%
141	02120201	Lower Susquehanna River	Velvet Rock Branch	Velvet Rock Branch	385	18.3	4.76%
142	02120202	Deer Creek	Deer Creek	Deer Creek	9,824	200	2.04%
142	02120202	Deer Creek	Deer Creek	Deer Creek	16,441	443	2.70%
143	02120202	Deer Creek	Deer Creek	Deer Creek	3,884	90.0	2.32%
144	02120202	Deer Creek	Deer Creek	Deer Creek	2,617	60.6	2.31%
145	02130704	Bynum Run	Bynum Run	Bynum Run	3,130	426	13.62%
146	02130704	Bynum Run	Bynum Run	Bynum Run	2,236	68.1	3.04%
147	02130704	Bynum Run	Bynum Run	Bynum Run	1,897	273	14.37%
148	02130706	Swan Creek	Swan Creek	Swan Creek	1,214	18.2	1.50%
149	02130706	Swan Creek	Swan Creek	Swan Creek	2,631	93.9	3.57%
150	02130706	Swan Creek	Swan Creek	Swan Creek	1,063	52.6	4.94%
151	02130703	Atkisson Reservoir	Winters Run	Winters Run	2,035	209	10.26%
152	02130705	Aberdeen Proving Ground	Romney Creek	Romney Creek	531	1.1	0.21%
153	02130706	Swan Creek	Swan Creek	Swan Creek	2,022	42.5	2.10%
154	02130701	Bush River	Grays Run	Grays Run	2,440	49.9	2.05%
155	02130701	Bush River	Grays Run	Grays Run	808	44.7	5.54%
156	02130704	Bynum Run	Bynum Run	Bynum Run	2,241	257	11.48%
157	02130702	Lower Winters Run	Winters Run	Winters Run	3,216	509	15.84%
158	02130706	Swan Creek	Gasheys Creek	Gasheys Creek	1,663	41.4	2.49%
159	02130704	Bynum Run	Bynum Run	Bynum Run	2,020	182	9.00%
160	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Little Gunpowder Falls	2,817	271	9.63%
161	02130804	Little Gunpowder Falls	Little Gunpowder Falls	Little Gunpowder Falls	2,871	113	3.93%
162	02130703	Atkisson Reservoir	Winters Run	East Branch	1,070	35.9	3.35%
163	02130703	Atkisson Reservoir	Winters Run	East Branch	2,455	125	5.08%

Table 1
Summary of Harford County Subwatersheds and Impervious Cover

Feature ID	MD 8-Digit Watershed	MD 8-Digit Watershed Name	Watershed	Subwatershed	Subwatershed Area (Acres)	Subwatershed Impervious Area (Acres)	Percent Impervious
164	02130703	Atkisson Reservoir	Winters Run	West Branch	1,303	29.4	2.26%
165	02130703	Atkisson Reservoir	Winters Run	West Branch	2,235	115	5.14%
166	02130703	Atkisson Reservoir	Winters Run	Winters Run	1,771	77.5	4.38%
167	02130703	Atkisson Reservoir	Winters Run	Winters Run	2,226	185	8.29%
168	02130701	Bush River	Cranberry Run	Cranberry Run	2,309	189	8.19%
177	02120202	Deer Creek	Stout Bottle Branch	Cabbage Run	1,355	48.9	3.61%

Notes:
*Subwatershed assessment completed by Harford County.
**Subwatershed assessment completed for Sam's Branch by Harford County. The boundary of Sam's Branch overlaps with three existing subwatersheds.
Percent Impervious = [Subwatershed Impervious Area (Acres)/Subwatershed Area (Acres)] *100.

Table 2
Summary of Harford County 8-Digit Watersheds and Impervious Cover

MDE 8-Digit Watershed ID	MD 8-Digit Watershed Name	Land Coverage (Acres)	Percent Impervious
02120201	Lower Susquehanna River	20,847	3.21%
02120202	Deer Creek	93,165	2.81%
02120204	Conowingo Dam-Susquehanna River	15,538	3.42%
02120205	Broad Creek	25,363	2.54%
02130701	Bush River	45,837	6.59%
02130702	Lower Winters Run	8,468	11.65%
02130703	Atkisson Reservoir	29,076	6.48%
02130704	Bynum Run	14,583	11.05%
02130705	Aberdeen Proving Ground	21,625	0.01%
02130706	Swan Creek	16,862	2.77%
02130801	Gunpowder River	24,984	13.45%
02130804	Little Gunpowder Falls	37,339	5.05%
02130805	Loch Raven Reservoir	140,932	2.14%

Table 3
Summary of Harford County 8-Digit Watersheds TMDLS

MDE 8-Digit Watershed ID	MD 8-Digit Watershed Name	Substance	Percent Reduction
02130701	Bush River	PCBs	62.0%
02130704	Bynum Run	TSS	19.7%
02130706	Swan Creek	TSS	13.0%
02130805	Loch Raven Reservoir	Phosphorus	15.0%

Table 4
Summary of Harford County Subwatersheds Land Use Cover

Land Use Classification	Land Coverage (Acres)	Total Land Area (acres)	Percent Coverage (%)
Agriculture	79,907	242,738	32.9
Barren Land	514	242,738	0.21
Forest	90,561	242,738	37.3
Not Classified	1,157	242,738	0.48
Transportation	1,372	242,738	0.57
Urban Land Use	66,652	242,738	27.5
Water	1,866	242,738	0.77
Wetlands	709	242,738	0.29

Notes:
Percent Coverage = [Land Coverage (acres)]/[Total Land Area (acres)]*100

Table 5
Summary of Harford County Subwatershed Prioritization

Priority Ranking	MD 8-Digit Watershed	MD 8-Digit Watershed Name	Feature ID	Watershed	Subwatershed	Subwatershed Area (Acres)	Subwatershed Impervious Area (Acres)	Percent Impervious
1	02130801	Gunpowder River	106	Gunpowder Falls	Gunpowder Falls	673	149.1	22.15%
2	02130702	Lower Winters Run	157	Winters Run	Winters Run	3216	509.4	15.84%
3	02130704	Bynum Run	145	Bynum Run	Bynum Run	3130	426.4	13.62%
4	02130704	Bynum Run	147	Bynum Run	Bynum Run	1897	272.7	14.37%
5	02130701	Bush River	57	Bush Creek	Bush Creek	924	122.0	13.20%
5	02130704	Bynum Run	159	Bynum Run	Bynum Run	2020	181.8	9.00%
6	02130703	Little Gunpowder Falls	45	Little Gunpowder Falls	Wildcat Branch	816	106.2	13.03%
7	02130701	Bush River	56	Church Creek	Church Creek	1977	251.2	12.71%
8	02130801	Gunpowder River	131	Reardon Inlet	Reardon Inlet	1018	121.6	11.95%
9	02130804	Bush River	70	Haha Branch	Haha Branch	1597	188.7	11.82%
10	02130804	Lower Winters Run	71	Otter Point Creek	Otter Point Creek	2295	337.6	14.71%
10	02130701	Bush River	77	Bush River	Bush River	50	1.8	3.54%
10	02130701	Bush River	78	Monks Creek	Monks Creek	177	18.9	10.68%
10	02130704	Bush River	80	Lauderick Creek	Lauderick Creek	400	56.2	14.04%

Notes:
Priority Ranking: Subwatersheds were prioritized based on % impervious cover, opportunities for combining subwatersheds and efforts, TMDLs
Percent Impervious = [Subwatershed Impervious Area (Acres)/Subwatershed Area (Acres)] *100.

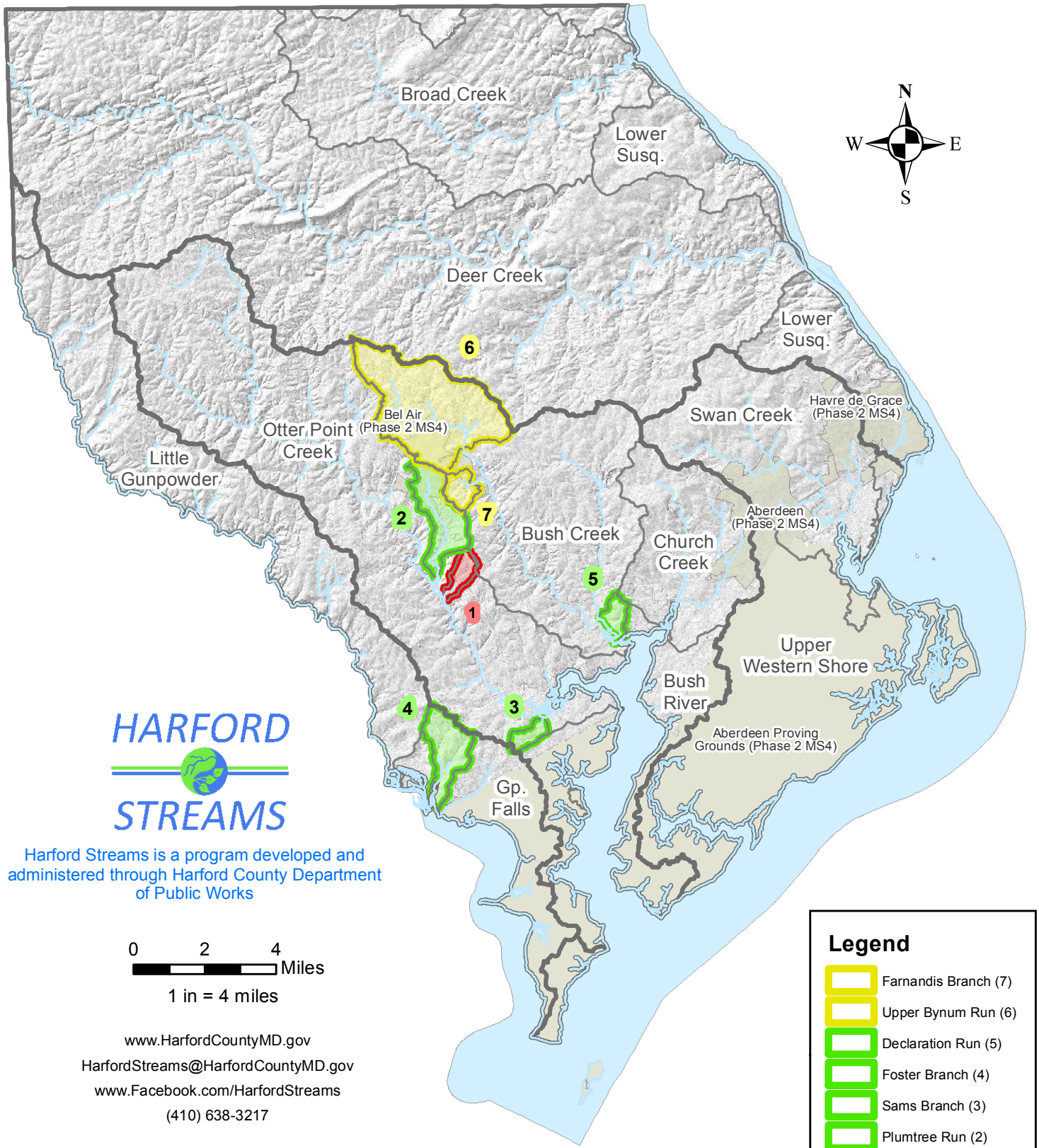
Summary of Restoration Projects by Watershed Assessment

Appendix E1

Harford County, MD Department of Public Works
Watershed Protection and Restoration

Barry Glassman
County Executive

Watershed Assessments Active, Pending, or Complete during FY2017



HARFORD STREAMS

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0 2 4 Miles

1 in = 4 miles

www.HarfordCountyMD.gov
HarfordStreams@HarfordCountyMD.gov
www.Facebook.com/HarfordStreams
(410) 638-3217

Legend

- Farnandis Branch (7)
- Upper Bynum Run (6)
- Declaration Run (5)
- Foster Branch (4)
- Sams Branch (3)
- Plumtree Run (2)
- Wheel Creek (1)

NPDES Phase 1 MS4 Permit 11-DP-3310
Printed 12/2017

Harford County, MD Department of Public Works
Watershed Protection and Restoration
Watershed Assessments

Barry Glassman
County Executive

Watershed	Completed	Drainge (ac)	Impervious (ac)	
Wheel Creek	2008	440	120	27%
Plumtree Run	2011	1,650	480	29%
Foster Branch	2012	1,420	250	18%
Sams Branch	2012	370	90	24%
Riverside	2014	300	110	37%
Declaration Run	2014	430	110	26%
	Totals	4,610	1,160	25%

Harford Streams

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Harford County, MD Department of Public Works
Watershed Protection and Restoration
Wheel Creek Stream Improvement Projects

Barry Glassman
County Executive

Wheel Creek Watershed Assessment (2008)
(440 acres / 120 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000030	Wheel Creek at Calvert Walks Stream Restoration	2013	1	7.25	$324,682	$204,951	$44,784
WP000022	Wheel Creek at Gardens of Bel Air SWM Retrofit	2013	1	4.79	$322,120	$178,804	$67,248
WP000026	Wheel Creek at Festival at Bel Air SWM Retrofit	2016	1	12.00	$385,601	$195,436	$32,133
WP000024	Wheel Creek at Country Walk 1A SWM Retrofit	2016	2	8.66	$588,826	$324,119	$67,994
WP000025	Wheel Creek at Country Walk 1B SWM Retrofit	2017	1	3.66	$530,480	$121,623	$144,940
WP000027	Lower Wheel Creek SWM Retrofit & Stream Restoration	2017	6	65.81	$2,147,002	$1,420,177	$32,624
			Totals	102.17	$4,298,710	$2,445,111	$42,074

Harford Streams

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Harford County, MD Department of Public Works
Watershed Protection and Restoration
Plumtree Run Stream Improvement Projects

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County Executive

Plumtree Run Watershed Assessment (2011)
(1650 acres / 480 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000088	Stormwater Retrofit at Homestead Elementary	Active	1	3.00	$131,374	$0	$43,791
WP000087	Tributary to Plumtree Run at Wakefield Manor Stream Restor	Active	1	3.00	$94,554	$0	$31,518
WP000039	Plumtree Run at Barrington Stream Restoration	Active	6	32.20	$3,063,462	$0	$95,139
WP000035	Ring Factory ES SWM Retrofit & Stream Restoration	Active	3	20.18	$1,449,423	$660,132	$71,825
WP000040	Pumphrey Property Demolition	2009	3	0.51			
WP000013	Plumtree Run at Tollgate Stream Restoration	2011	1	16.80	$428,877	$215,000	$25,528
			Totals	75.69	$5,167,690	$875,132	$68,274

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Harford County, MD Department of Public Works
Watershed Protection and Restoration
Foster Branch Stream Improvement Projects

Barry Glassman
County Executive

Foster Branch Watershed Assessment (2012)
(1420 acres / 250 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000099	Foster Branch at Pine Road Stream Restoration	Active	1	30.00	$1,600,000	$0	$53,333
WP000037	Foster Branch at Stillmeadow Stream Restoration	Active	3	21.69	$1,829,770	$0	$84,360
WP000019	Woodbridge SWM Retrofit	2013	1	3.80	$256,467	$0	$67,491
WP000032	Foster Branch at Trimble Road Stream Restoration	2014	1	12.10	$570,051	$275,000	$47,112
WP000020	Woodbridge Stream Restoration	2015	1	12.40	$553,083	$258,832	$44,603
WP000036	Foster Branch at Dembytown Stream Restoration	2017	2	21.20	$915,752	$500,000	$43,196
			Totals	101.19	$5,725,123	$1,033,832	$56,578

Harford Streams

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Harford County, MD Department of Public Works
Watershed Protection and Restoration
Sams Branch Stream Improvement Projects

Barry Glassman
County Executive

Sams Branch Watershed Assessment (2012)
(370 acres / 90 acres impervious)

	Project	Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000033	Willoughby Beach SWM Retrofit & Stream Restoration	Active	6	33.20	$1,634,509	$1,100,000	$49,232
WP000042	Washington Court Demolition	2011	1	2.11			
			Totals	35.31	$1,634,509	$1,100,000	$46,290

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Harford County, MD Department of Public Works
Watershed Protection and Restoration
Declaration Run Stream Improvement Projects

Barry Glassman
County Executive

Declaration Run Watershed Assessment (2014)
(430 acres / 110 acres impervious)

Project		Year Complete	Number of BMPs	Impervious Credits (ac)	Total Cost	Grants	Cost per Acre
WP000043	Northwest Branch Declaration Run Stream Restoration	Active	1	19.40	$1,206,252	$0	$62,178
WP000034	Church Creek ES SWM Retrofit & Stream Restoration	Active	3	24.22	$1,678,180	$0	$69,289
			Totals	43.62	$2,884,433	$0	$66,126

Harford Streams

Green Choices ... Healthy Streams

Harford Streams is a program developed and administered through Harford County Department of Public Works

Printed 11/20/2017

Deer Creek Assessment

DRAFT - Deer Creek Watershed Assessment

Harford County, Maryland

June 2017

Prepared for:

Harford County
Department of Public Works
212 South Bond Street
Bel Air, Maryland 21014

Prepared by:

KCI Technologies, Inc.
936 Ridgebrook Road
Sparks, Maryland 21152

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Executive Summary

The Deer Creek Watershed Assessment was initiated by the Harford County Department of Public Works to build on the 2007 Deer Creek Watershed Restoration Action Strategy. The goal of the WRAS was to convene all stakeholders in the watershed and bring together all the available to protect water quality, conserve fish and wildlife habitats, and restore those areas found to be impaired. The WRAS is a planning document that defines the issues that affect watershed health and provides potential solutions, or management strategies that watershed and landuse managers can use to correct them. This Deer Creek Watershed Assessment updates watershed condition with data collected since the completion of the WRAS and suggests potential restoration projects for implementation to help Harford County meet its Chesapeake Bay TMDL mandates.

The Deer Creek Watershed is 171 square miles in size and is located in Harford and Baltimore Counties in Maryland and York County Pennsylvania. The Deer Creek flows to a confluence with the Susquehanna River. Close to 80 percent of the Watershed is located in Harford County. The Watershed retains a predominantly rural character with land use that is primarily agricultural (44 percent) and forest (28 percent). Less than one percent of the Watershed area lies within Harford County's development envelope and it has an overall existing imperviousness of only 4.3 percent.

The Deer Creek is a State Scenic River and Stream Use classifications include both natural and recreational trout waters. The Watershed is home to many rare, threatened and endangered species and maintains a high level of biodiversity. Sensitive terrestrial habitats are also present including Critical Areas, non-tidal Wetlands of Special State Concern and Habitats of Local Significance.

Based on previous studies and Deer Creek's current conditions a suite of restoration projects and activities were identified for implementation. At full implementation these projects would reduce nitrogen by 3,135.7 lbs/yr, phosphorus by 1,275.7 lbs/yr, and sediment by 867,181.4 lbs/yr. Full implementation of these recommendations is likely to take many years due to planning, project design, and funding limitations. During this implementation period it is imperative that land conservation activities continue in the watershed to keep the overall watershed condition from becoming impaired over time.

1 Introduction

1.1 Background

The Deer Creek Watershed Assessment was initiated by the Harford County Department of Public Works to identify potential projects for implementation in the Deer Creek watershed and those resources that are of high quality and are in need of protection. The assessment is also prepared in response to requirements set forth by the Maryland Department of the Environment (MDE) in the County's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit (11-DP-3310 MD0068268), issued on December 30, 2014. The watershed assessment supports the County's goals for healthy watersheds and natural resources, and also support progress towards satisfying several regulatory and permit requirements.

In 2007 the Harford County Department of Planning and Zoning completed the Deer Creek Watershed Restoration Action Strategy (WRAS) (KCI, 2007). The WRAS was completed in cooperation with the Maryland Department of Natural Resources (MDNR), Maryland Department of the Environment (MDE) and the Harford County Soil Conservation District (HSCD). The WRAS included a watershed characterization, identification of water quality problems, field assessment of current conditions, identification of management strategies and specific project sites, and cost estimates with funding opportunities and strategies. The WRAS was developed with a public input gathered through a series of public forums. The WRAS included most all of the watershed assessment elements required by the County's current NPDES permit; however the WRAS predates the current focus on Total Maximum Daily Loads (TMDL) and current accounting practices used for impervious surface treatment. Therefore this Deer Creek Watershed Assessment provides an update of the 2007 WRAS, with current requirements addressed including TMDLs, impervious surface reduction and estimates of treatment progress that could be achieved through completion of identified strategies and projects.

1.2 Goals

The watershed assessment makes progress toward satisfying section IV.E.1 of the NPDES permit to develop detailed watershed assessments for the entire County by the end of the permit term (2019) with a focus on urban stormwater sources and restoration. The assessment identifies management strategies that support several planning goals, including:

- Implementation of restoration efforts for twenty percent of the County's impervious area;
- Meeting Chesapeake Bay TMDL stormwater load reduction targets; and

To accomplish these goals the assessments is structured to meet the following objectives:

- Characterize current watershed conditions;

- Identify water quality and watershed problems;
- Identify and prioritize water quality improvement projects;
- Estimate pollutant load reductions achievable with implementation of the plan.

Because the primary goal of this current study is related to the urban stormwater sector and meeting the restoration goals of the NPDES permit, watershed elements such as rare, threatened and endangered species, coastal waterways, climate impacts, etc. while extremely important are outside of the scope of this current effort. These elements are addressed in other State and County planning efforts and the results of this study can be combined with those efforts to address a wider range of watershed features.

1.2.1 Impervious Restoration

As a requirement of the NPDES MS4 Discharge Permit issued by MDE to Harford County, the County must treat 20% of remaining baseline untreated impervious acres by the end of the current permit term in December, 2019. Impervious accounting methodology is included in Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated (MDE, 2014). Untreated impervious includes those areas where stormwater practices provide less than the current Maryland standard water quality volume for runoff from 1" of rainfall. Section 3 of this report describes the impervious credits estimated for the potential projects identified in the assessment.

1.2.2 TMDLs

The total allowable load to a waterbody consists of two categories of sources: point sources (Wasteload Allocation or WLA) and non-point sources (Load Allocation or LA). Stormwater regulated by NPDES permits is regulated as a point source. In Maryland, MDE designates this allowable load as the SW-WLA. They may also include other components, a Margin of Safety (MOS) which has generally been included implicitly in the analysis, and a Future Allocation (FA) which is used to account for growth in wastewater point sources and is not frequently included.

There are no local TMDLs with SW-WLAs assigned to Harford County for the Deer Creek watershed.

Chesapeake Bay TMDL

In December, 2010, the U.S. Environmental Protection Agency (EPA) published the Chesapeake Bay TMDL. The Bay TMDL sets limits on loading of three pollutants (nitrogen, phosphorus and sediment) delivered to the Bay from contributing segments, such as the Deer Creek watershed.

The County's MS4 permit is requiring compliance with the Chesapeake Bay TMDL for the urban stormwater sector through the use of the 20% impervious surface treatment strategy. Therefore, it is expected that the 20% goal and associated credit accounting will take precedence over the Bay TMDL loading goals and crediting. While not a requirement in the County's MS4 permit, the strategies provided in this plan have been modeled in order to calculate expected progress toward meeting pollutant reduction goals.

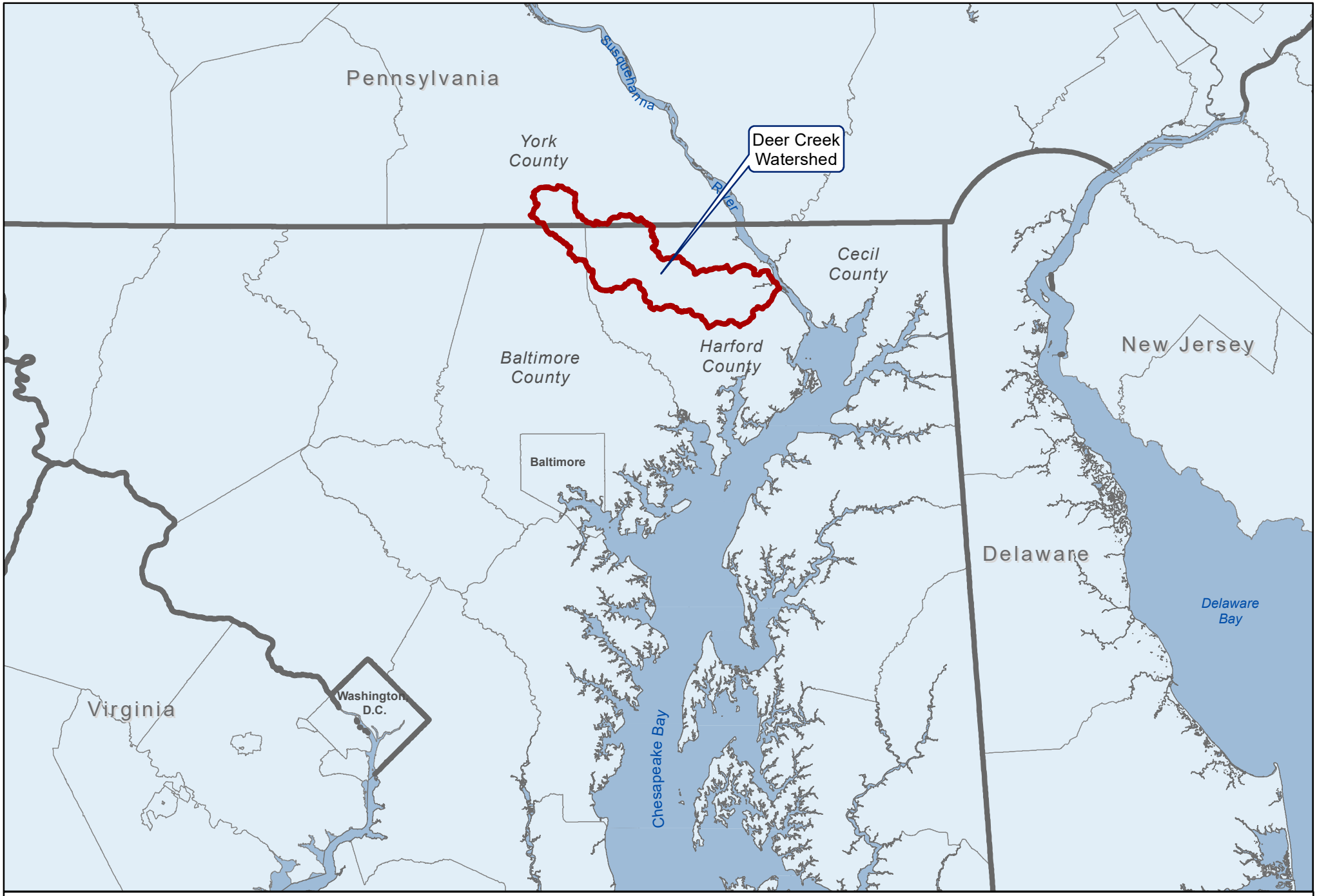
1.3 Deer Creek Watershed Description

The Deer Creek Watershed is the largest watershed in Harford County, covering 38 percent of the County's land area. Other major watersheds in the County include the Bush River, Broad Creek and the Gunpowder River. The entire watershed covers approximately 109,400 acres (171 square miles) across two states and three counties. In Maryland there are 86,000 acres in Harford County, and 7,160 acres in Baltimore County. The Pennsylvania portion of the watershed lies in York County and covers 16,250 acres (see Maps 1 and 2, below).

The Deer Creek flows from its headwaters in York and Baltimore Counties in a southeasterly direction to a confluence with the Susquehanna River near Susquehanna State Park. Deer Creek lies in the Piedmont physiographic region and is part of the Upper Western Shore Basin.

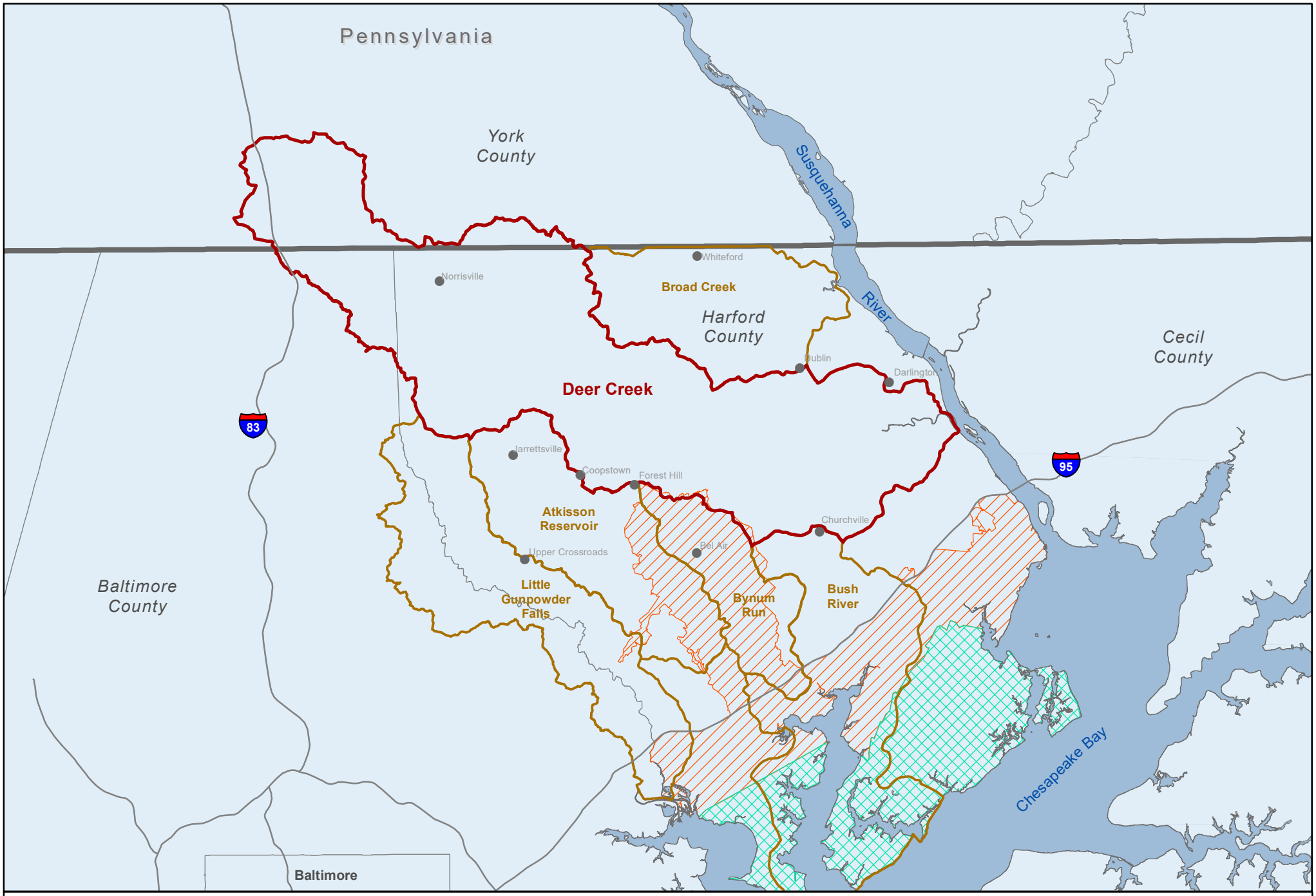
Land use in the Watershed has been historically agricultural. The area retains its agricultural heritage through preservation programs and the watershed lies outside the County's "development envelope." As of 2010 the Harford County portion of the watershed is comprised of agricultural use (44 percent), forest (28 percent) and developed land (27 percent).

Sensitive species in the Watershed include the bald eagle, bog turtle, Davis' sedge, butternut, brook trout, Maryland darter and the Chesapeake logperch. The Deer Creek was named a State Scenic River in 1973; a local Scenic River Advisory Board has been established to promote the protection of the natural and cultural values of Deer Creek. Many streams in the Watershed are designated trout waters.



DEER CREEK
Watershed Assessment

Map 1: Vicinity Map



DEER CREEK
Watershed Assessment

Map 2: Watershed Location Map

1.4 Harford County Planning and Deer Creek

The 2016 HarfordNEXT - A Master Plan for the Next Generation (Harford County, 2016) lays out the major policies of the County for addressing future growth and preservation and protection of agricultural and natural resources. The current plan continues the concept of a "Development Envelope", first introduced in the 1977 Master Plan, in which a specific geographic area is designated for planned development. Less than 1 percent of the Deer Creek watershed lies within this "Development Envelope."

Preservation of the rural heritage of the County and protection of the natural environment are major goals addressed in HarfordNEXT:

- Goal: Protection of natural, historical, and cultural resources
- Goal: Protection of rural areas

Protection of the County's natural environment focuses on maintaining high quality surface and groundwater resources, and protecting and enhancing the County's wetland and forest resources, open space and greenways, and riparian buffers. Watershed planning is identified as an important tool in this effort, and specifically implementing the recommendations from the Deer Creek WRAS.

Protection of its agricultural and rural heritage is of great importance to the County. Many efforts are currently underway to maintain the County's agricultural industry, ranging from a nationally recognized agricultural preservation program to an Agricultural Economic Development initiative addressing the economic viability of agriculture.

2 Watershed Conditions

The 2007 Deer Creek WRAS development was supported by several technical studies and documents completed in 2005-2006. They include the Deer Creek Watershed Characterization (MDE, 2006a), the Report on Nutrient Synoptic Survey (MDE, 2006b) and the Stream Corridor Assessment (MDE, 2006c), MDNR provided aquatic condition assessment in the form of an Aquatic Conservation Target analysis (MDNR, 2006) and raw and summarized data from the Maryland Biological Stream Survey (MBSS).

The data collected and analyzed in these studies provided a watershed-wide assessment of the status of water quality, biological condition, stream condition, land use and general watershed health. The reports are summarized below with additional information added. This watershed assessment built on the characterization work from the WRAS, adding up-to-date data where available.

2.1 Watershed Characterization

The Deer Creek Watershed Characterization (MDE, 2006a) summarized existing data resources and overall characterization of water quality, living resources, habitat and landscape. In addition, the report highlighted related projects and restoration targeting tools. The Characterization, as support to the WRAS, met several objectives:

- Summarize available information and issues,
- Provide preliminary findings based on this information,
- Identify sources for more information or analysis,
- Suggest opportunities for restoration work, and
- Provide a common base of knowledge about the watershed for government, citizens, businesses and other interested groups.

2.1.1 Water Quality

Use Designations

The Maryland Department of the Environment (MDE) has established acceptable standards for several water quality parameters for each designated Stream Use Classification. These standards are listed in the *Code of Maryland Regulations (COMAR) 26.08.02.01-.03 - Water Quality* (MDE 1994). The Deer Creek is classified in portions as Use III-P, which is natural trout waters and public water supply and as Use IV-P, which is recreational trout waters and public water supply. The acceptable standards for Use III-P and Use IV-P are listed below.

Table 1: COMAR Standards

Parameter	Units	Acceptable COMAR Standard
pH	standard pH units	IV-P and III-P: 6.5 to 8.5
Temperature	degrees Celsius, °C	IV-P: maximum of 75°F (23.9°C) or ambient temp. of the surface water, whichever is greater. III-P: maximum of 68°F (20°C) or ambient temp. of the surface water, whichever is greater. IV-P and III-P: a thermal barrier that adversely affects aquatic life may not be established.
Dissolved Oxygen (DO)	milligrams per liter, mg/L	IV-P: may not be less than 5 mg/l at any time. III-P: may not be less than 5 mg/l at any time, minimum daily average not less than 6 mg/l.
Turbidity	Nephelometer Turbidity Units, NTU	IV-P and III-P: maximum of 150 NTUs and maximum monthly average of 50 NTUs
Toxics	na	IV-P and III-P: All toxic substance criteria to protect fresh water organisms, public water supply and the wholesomeness of fish for human consumption.

In the Deer Creek watershed the Use III-P designation is applied to all bodies of water above Eden Mill Dam and the following streams below the dam:

- - Elbow Branch and all tributaries
- - Gladden Branch and all tributaries
- - Kellogg Branch and all tributaries
- - Little Deer Creek and all tributaries
- - North Stirrup Run and all tributaries
- - Rock Hollow Branch and all tributaries
- - South Stirrup Run and all tributaries
- - Unnamed Tributary to Deer Creek near Rock Ridge Road
- - Wet Stone Branch and all tributaries

Use IV-P is applied from the mouth of Deer Creek to Eden Mill Dam, excluding the streams listed above.

Deer Creek is used as a source of public drinking water supply for about 12,000 people in the Aberdeen Area of Aberdeen Proving Ground (APG). The Source Water Assessment for Deer Creek at the Chapel Hill Water Treatment Plant (MDE, 2005), report indicates that both point and non-point sources of contamination exist in the watershed. Non-point sources are the most significant contributors. From a public drinking water supply perspective, the report indicates that

turbidity (sediment), disinfection byproduct precursors and pathogenic microorganisms are the contaminants of most concern. High turbidity levels are associated with erosion and sediment transport during storm flows. *E. coli* and fecal bacteria were present consistently in Deer Creek during a two-year sampling program, with the highest concentrations occurring in association with rainfall.

Impaired Waters 303(d)

Stream and water bodies not meeting their use criteria are listed on MDE's Section 303(d) list of impaired waters. Since 2002 several segments of the Deer Creek watershed have been listed and delisted based on MBSS fish and benthic macroinvertebrate data for biological impairments with unknown causes. In April of 2014 the state water quality standards were updated to include water quality standards for water temperature. This update affected several stream reaches in the Deer Creek watershed. As of the current 2014 303(d) list for the Deer Creek, several subwatersheds are included for biological impairment. All are low priority for TMDL development.

Table 2: Deer Creek 303(d) list segments

Listing Category	Code	WRAS Subwatershed Name	Pollutant
2	02120202	Deer Creek	Unknown
	021202020327	Middle Deer Creek Rock Hollow Wet Stone	Water Temperature
	021202020330	Upper Deer Creek Jackson Branch and Island Branch	Water Temperature
5	021202020330	Upper Deer Creek Jackson Branch and Island Branch (three segments)	Water Temperature
	021202020331	Big Branch (two segments)	Water Temperature

Listing Categories

2: meeting some standards but insufficient information to determine attainment of other standards

5: waterbodies that may require a TMDL

2.1.2 Living Resources and Habitat

Aquatic Resources

Because living resources are dependent on water systems, information on living resources is included as a measure of the water quality and habitat conditions of the Watershed.

Overall the diversity community structure of the fish and benthic macroinvertebrate populations is good. A total of 86 sites were sampled by MBSS from 1995-2015 with 65 sites sampled for fish and 86 sampled for benthic macroinvertebrates. Additionally, 309 sites were sampled by the Stream Waders volunteer program from 2000-2015. Their Benthic and Fish Indices of Biotic

Integrity (BIBI and FIBI) scores and ratings are listed below. The majority of sites were rated as either Good or Fair.

Table 3: Summary MBSS and Stream Waders Data

Type	Source	Sample Number	Good	Fair	Poor	Very Poor
BIBI	MBSS	86	53 (61.6)	28 (32.6)	3 (3.5)	2 (2.3)
BIBI	Stream Waders*	309	100 (32.4)	154 (49.8)	41 (13.3)	14 (4.5)
FIBI	MBSS	65	37 (56.9)	17 (26.2)	4 (6.2)	7 (10.8)

* Stream Waders assessment uses a family level BIBI rather than the genus level BIBI used by MBSS.

MDNR's Fish Passage Program has identified seven current blockages to fish passage and migration in the Deer Creek Watershed. The SCA identified 67 fish passage barriers, although none were more severe than moderate. Thirty of the barriers were considered partial or temporary. Of the 37 considered to be a total blockage, 14 were natural features, 3 were instream ponds, 1 was sandbags, and 19 were road crossings.

Trout

MDNR Fishing and Boating Services maintains trout fishery information. Trout areas currently are located on stream segments in 10 of the 20 Deer Creek subwatersheds. Starting in 2010, MDNR Fishing and Boating Services and Resource Assessment Service collected water temperature and trout presence data throughout the Deer Creek watershed. The information collected during this multi-year sampling effort increased the number of stream miles with known cold water habitat and/or naturally-reproducing trout populations. The majority of these new distributional records were for brook trout, both Maryland's only native trout species and its only coldwater obligate fish species. This information was used by MDE in April of 2014 to redesignate several streams in the Deer Creek watershed from Use IV-P to the more protective Use III-P. With urbanization and non-native species negatively impacting brook trout populations in the Piedmont region of Maryland, these brook trout supporting streams in the Deer Creek watershed represent important populations for the preservation of Maryland's biodiversity and the genetic diversity of brook trout in Maryland.

Sensitive Species and Habitats

Sensitive species in the Watershed have been identified by MDNR's Wildlife and Heritage Service. Among those listed in Harford County are the bald eagle, bog turtle, brook trout, Maryland darter and the Chesapeake logperch. Chesapeake Bay Critical Area (CBCA) includes all lands within 1,000 feet of tidal waters or adjacent to tidal wetlands. These areas are subject to more stringent development guidelines. Critical Area in the Deer Creek Watershed is minimal and is concentrated in Lower Deer Creek and primarily in Susquehanna State Park. This area also

includes one of two nontidal Wetlands of Special State Concern (WSSC). The other is the Deer Creek Serpentine Barren, which is an area of serpentine rock formations, prairie-like grasses and unique species. The Wildlife and Heritage Service has also identified Habitats of Local Significance (HLS) in the County that provide specialized habitat to rare threatened or endangered species. Five habitats have been identified in the Deer Creek Watershed including Deer Creek Hillside, Stafford Road Slopes, the Northern Susquehanna Canal, Elbow Branch, and the Deer Creek Pumping Station.

Freshwater mussels are the most imperiled group of animals in North America with more than two-thirds of species either extinct, or listed as rare, threatened, or endangered. In Maryland 14 of 16 (87.5%) native species are listed as rare, threatened, or endangered, a higher rate of imperilment than North America as a whole. MDNR Wildlife and Heritage Service considers Deer Creek as the best existing freshwater mussel community in Piedmont Maryland. This led to Maryland State Highway Administration and MDNR to undertake a mussel relocation project in Deer Creek along Rt 24 at Rocks State Park during 2014 and 2015 (Ashton et al., 2015 and Ashton et al., 2016). Freshwater mussels are sensitive indicator species that are affected by low levels of human-caused change in the watershed. Changes in water quality and instream sedimentation have negative effects on freshwater mussel communities. Keeping the low level of development in the watershed and implementing agricultural BMPs will greatly help preserve these animals as part of the biodiversity in Deer Creek (McCann personal communication.).

2.1.3 Landscape

The activities on the land have both direct and indirect impacts on water quality, terrestrial and aquatic habitat, and biota. Analysis of land use and impervious surfaces was completed for the entire Deer Creek Watershed including Baltimore and York Counties. Descriptions of the methods and results are located in sections 2.3 and 2.4. The results of the Characterization Report (MDE, 2006) for growth projections and other landscape issues are summarized below and updated with recent data as available.

Development and Growth

Under Maryland's Planning Act and Smart Growth Initiatives Priority Funding Areas (PFA) were created where development and infrastructure support would be targeted. In Harford County the main PFA is the Development Envelope. The goal of the Development Envelope when it was created in 1977 was to focus new development in areas that would be served by public sewer and water would be provided. Less than 1 percent of the Deer Creek Watershed lies within the envelope at the very southern upstream end of Stout Bottle Cabbage Run, Middle Deer Creek St. Omar and Thomas Run. Rural Villages were also created as PFAs in rural parts of the County.

One is located entirely within the Watershed in Upper Deer Creek Plumtree and Upper Deer Creek Jackson Branch. Five other Rural Villages are located on the fringes of the Watershed.

Development in the County is concentrated in the Development Envelope; however some residential development does occur in the watershed. Between 1977, when the Development Envelope was initiated, and 2010 80% of new development occurred within the envelope. An analysis of new building activity within the watershed was completed and presented in the Deer Creek Watershed Characterization report (MDE, 2006). That analysis found an average of 135 building permits were issued each year in the Deer Creek Watershed between 1998 and 2004 representing 7.3 percent of the County total. Based on Harford County Agricultural Land Inventory completed in 2002 there were estimated to be approximately 3,940 undeveloped residential lots. Applying the average building permits by year to the approximate number of available lots, build-out of Harford County's portion of the watershed may occur by 2032. Complete build-out is likely to occur later than 2032 due in part to the housing downturn in the late 2000s and the difficulty in determining how many family conveyance lots remain unbuilt. According to the Harford County Commercial Land Inventory, which was updated in 2004, there were 416 acres of commercially zoned vacant land.

Protected Lands

Protected lands are any areas that have long-term established limitations on conversions to a developed use. There are many types of protections in Deer Creek varying from public ownership, to the many types of easements. Between State and County Parks, 3,920 acres or 4 percent of the Maryland portion of Deer Creek is public. Permanent easements on private land in Deer Creek are primarily held in agricultural easements. Lesser amounts are held in Conservation easements. The total Deer Creek easement acreage in Maryland as of June 2007 is 27,099 or 29 percent of the watershed in Maryland. Total protected lands are 32 percent of the Maryland watershed.

Maryland's Rural Legacy Program seeks to protect valuable agricultural, forestry and natural and cultural resources. The Lower Deer Creek Valley Rural Legacy Area was established in 1999 to aid protection of the Deer Creek Watershed through easements.

Deer Creek is a designated under the State Wild and Scenic River Program and Harford County has established a Deer Creek Scenic River District. These designations have established a 150 foot buffer along both sides of Deer Creek to preserve the creek's natural aesthetic beauty along its entire length in Maryland.

Forest and Wetlands

Forests and wetlands provide critical habitat and environmental benefits such as filtering and cooling air and water, trapping sediment and pollutants and attenuating stream flows. The Maryland portion of the Deer Creek Watershed contains 26,470 acres of forested area as of 2010

(MDP, 2010). Of this, 12,099 acres (46%) is considered high quality forest interior dwelling species (FIDS) habitat. High quality FIDS habitat is mature forest of at least 100 acres in size with at least 25% of the total area with the forest edge at least 300 feet away. This high-quality forest is preferred by certain species that require a type of habitat isolated from non-forested areas. Additional forest area in the Watershed includes 5,151 acres of large block forest habitat (19% of total forested area) and 12,168 acres (46%) of other forested land.

Deer Creek Watershed contains both riverine and palustrine wetlands. Riverine wetlands are freshwater wetlands generally found on floodplains adjacent to rivers and streams. Palustrine wetlands are freshwater wetlands associated with high water tables and ponding in upland depressions and include inland marshes and bogs. Conservatively, there are an estimated 410 acres of wetlands in the Maryland portion of the Deer Creek Watershed. This includes all types of freshwater wetlands, with the majority being palustrine wetlands.

2.2 Subwatershed Delineation

It is difficult to develop a specific understanding of conditions and specific recommendations of measurable management strategies at the scale of the Deer Creek Watershed without breaking the study area into smaller more manageable units. The Deer Creek Watershed, which is 171 square miles, is an 8-digit Maryland watershed (02120202) that includes 12, 12-digit watersheds. This breakdown was used in the Watershed Characterization. The 12-digit watersheds include only the Maryland portion, which excludes Pennsylvania, and range in size from 5.8 square miles to 24.3 square miles. For the purposes of the WRAS the Pennsylvania portion of the watershed was added and the original 12-digit subwatersheds were modified to develop a final total of 20 subwatersheds ranging in size from 6.27 square miles to 14.11 square miles with a an average size of 8.5 square miles. Each of the 20 subwatersheds was given a numerical ID from 1-20 that was used throughout the development of the WRAS. In large part the original 8-digit boundary was not adjusted during the delineation. The final subwatershed delineation is shown on Map 3.

Table 4: Deer Creek WRAS Subwatersheds

ID	Subwatershed	Area (acres)	Area (mi^2)	Stream length (miles)	County
1	Big Branch	5,145	8.04	12.37	H, Y
2	Falling Branch	4,749	7.42	9.90	H, Y
3	Island Branch	4,179	6.53	12.10	H, Y
4	Little Deer Creek Lower	5,143	8.04	14.20	H
5	Little Deer Creek Upper	3,879	6.06	11.16	H
6	Lower Deer Creek	6,462	10.10	21.40	H

ID	Subwatershed	Area (acres)	Area (mi^2)	Stream length (miles)	County
7	Lower Deer Creek Mill Hopkins Hollands Graveyard	9,033	14.11	27.24	H
8	Lower Deer Creek Tobacco Run Cool Branch	5,382	8.41	15.81	H
9	Middle Deer Creek	4,012	6.27	9.50	H
10	Middle Deer Creek Kellogg	4,386	6.85	12.94	H
11	Middle Deer Creek Rock Hollow Wet Stone	5,825	9.10	17.34	H
12	Middle Deer Creek St. Omar	7,123	11.13	17.62	H
13	Stirrup Run	4,199	6.56	12.66	H
14	Stout Bottle Cabbage Run	4,653	7.27	11.48	H
15	Thomas Run	5,290	8.27	12.82	H
16	Upper Deer Creek 1	4,898	7.65	15.83	B, Y
17	Upper Deer Creek 2	6,215	9.71	17.15	Y
18	Upper Deer Creek Ebaughs Creek	4,404	6.88	13.59	B, Y
19	Upper Deer Creek Jackson Branch	6,663	10.41	22.22	H, B
20	Upper Deer Creek Plumtree	7,705	12.04	25.56	H, B, Y

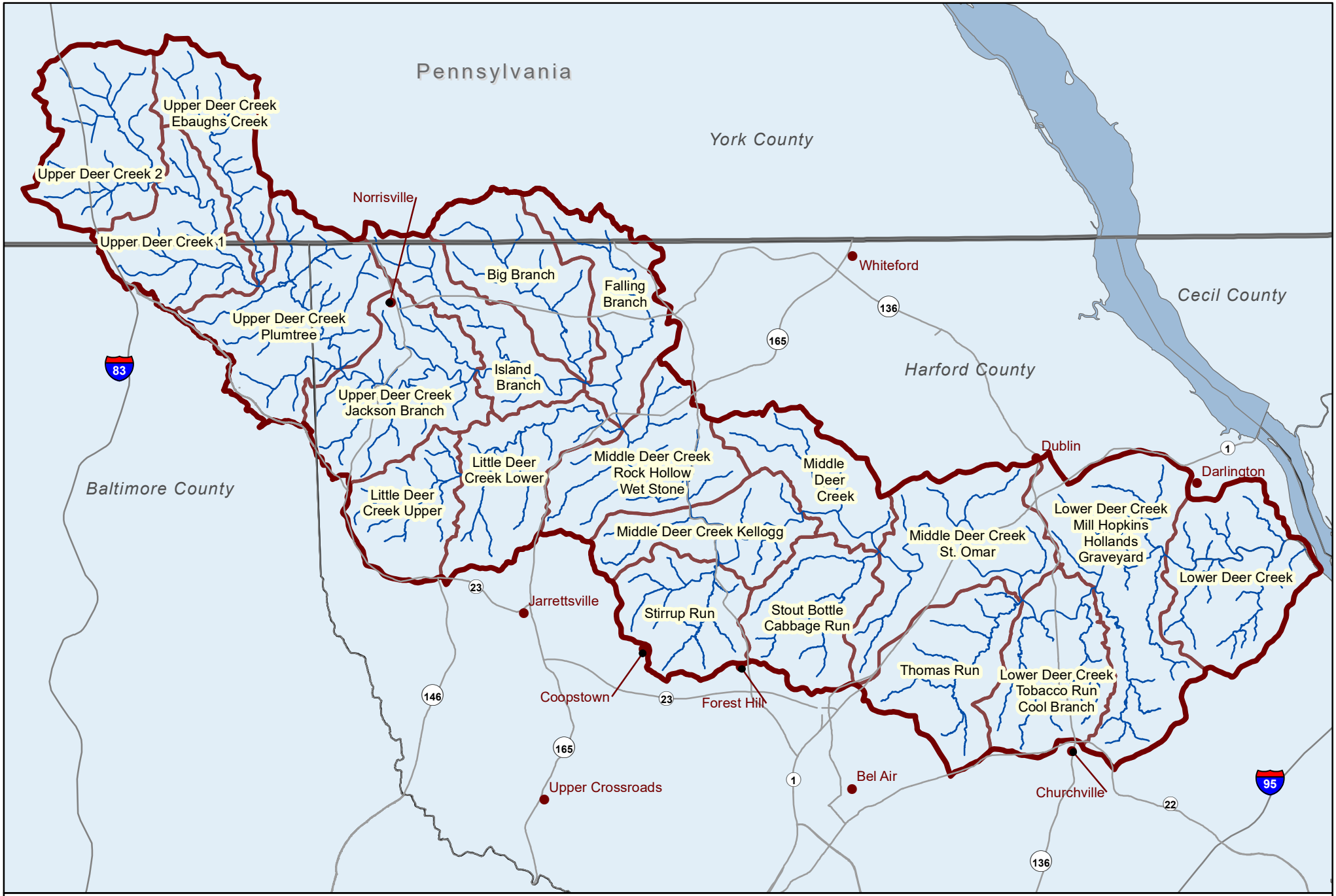
2.3 Land Use

Analysis of land use and land cover data is used as a screening tool to distinguish those areas of the Watershed that may be impacted currently from historical land conversion and existing land use.

2.3.1 Land Use Methods

GIS land use layers were supplied by Maryland Department of Planning (MDP) for the Maryland portion of the Watershed. The most recent MDP land use data available are from 2010. Maryland Department of Planning uses land use codes which identifies 24 separate land use classifications (Anderson Level II system). For Pennsylvania the York County Planning Commission (YCPC) supplied land use data; however, there were only seven classifications and the data did not meet the needs of the study. Instead a raster based land cover dataset from the National Land Cover Database (NLCD) from the Multi-Resolution Land Characteristics Consortium was used to characterize land cover throughout the entire watershed. The NLCD land cover map was developed for the entire United States (Homer et al., 2015) using 30 meter grids and a land cover classification using 20 separate classes modified from the Anderson Level II system. The most recent NLCD data are from 2011.

Land cover from the NLCD was used to characterize the entire watershed. Harford County's portion of the watershed was characterized using MDP land use. Map 4 shows the existing Maryland and Pennsylvania land use in the Deer Creek Watershed. The NLCD appears to show a lower amount of urban development in the entire watershed than the MDP land use for Maryland's portion or for Harford County's portion. This apparent difference in levels of urbanization is due to data differences between the NLCD land cover and the MDP land use. The NLCD classifies each 30x30-meter square in the watershed where the MDP classifies land use based roughly on property boundaries. The difference in methods is most observable in low-density and large lot subdivisions where MDP classifies the entire parcel and NLCD can classify part as urban and part as forest or grassland/pasture. The NLCD data are presented to generally characterize the entire watershed and should not be directly compared to the MDP data.



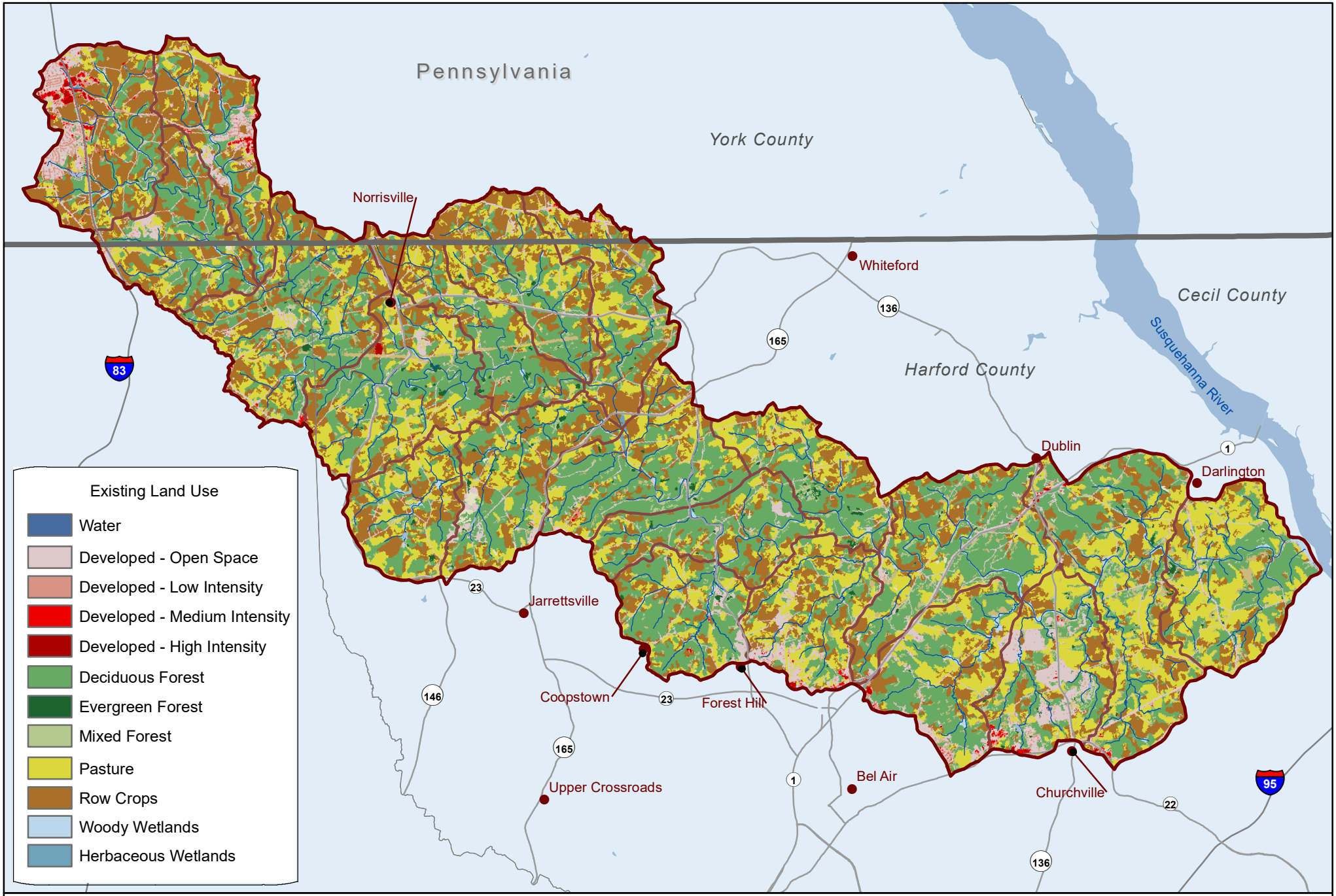
Subwatershed Outline
Streams
Roads
Towns

NORTH

1 inch = 3 miles

DEER CREEK
Watershed Assessment

Map 3: Subwatersheds



DEER CREEK
Watershed Assessment

Map 4: NLCD Land Use

2.3.2 Land Use Results

Deer Creek is a rural watershed, with approximately half of the total area in agricultural uses. Another third of the total area is forested. Urban land uses make up about a quarter of the total subwatershed area. The urban areas are largely low-density and large lot subdivisions with much lower levels of impervious surfaces than medium and higher density development would have. These residential areas are evenly dispersed throughout the Watershed with a few more heavily concentrated areas located in the Little Deer Creek Upper and Little Deer Creek Lower subwatersheds near Jarrettsville, Stout Bottle Cabbage Run and Stirrup Run near Forest Hill, Lower Deer Creek Tobacco Run Cool Branch near Churchville and in the Pennsylvania township of Shrewsbury along Interstate 83 in the Upper Deer Creek 2 subwatershed. Concentrations of commercial areas are limited to areas near Churchville and just south of Dublin in the Middle Deer Creek St. Omar and Lower Deer Creek Mill Hopkins Hollands Graveyard subwatersheds. There are also more extensive commercial areas in Pennsylvania along the I-83 corridor in the Upper Deer Creek 2 subwatershed.

Table 5: Summarized Landuse

Land Use (Combined to Anderson Level I*)	Watershed (NLCD)	Maryland Portion (MDP)	Harford County Portion (MDP)
Urban	10.7	26.7	27.4
Agricultural	49.1	44.6	44.1
Forest	39.0	28.4	28.3
Wetlands	0.9	0.0	0.0
Barren	0.0	0.1	0.2
Water	0.1	0.1	0.1
Other	0.3	0.0	0.0

*land use categories have been combined to Anderson Level I for descriptive purposes

2.4 Impervious Surface Analysis

There is evidence to suggest that total levels of impervious surface in a watershed are directly related to a watershed's overall condition. Imperviousness is the most important contributor to increased storm water runoff, thermal pollution, and a number of pollutants, particularly those related to automotive uses.

Generally subwatersheds with higher levels of imperviousness have correspondingly lower levels of water quality and biological health. Because of this relationship, the existing impervious cover estimates were used as indicators of prioritization at the subwatershed level.

Analysis of the existing imperviousness are used to distinguish those areas of the Watershed that may be impacted currently from high levels of impervious surface.

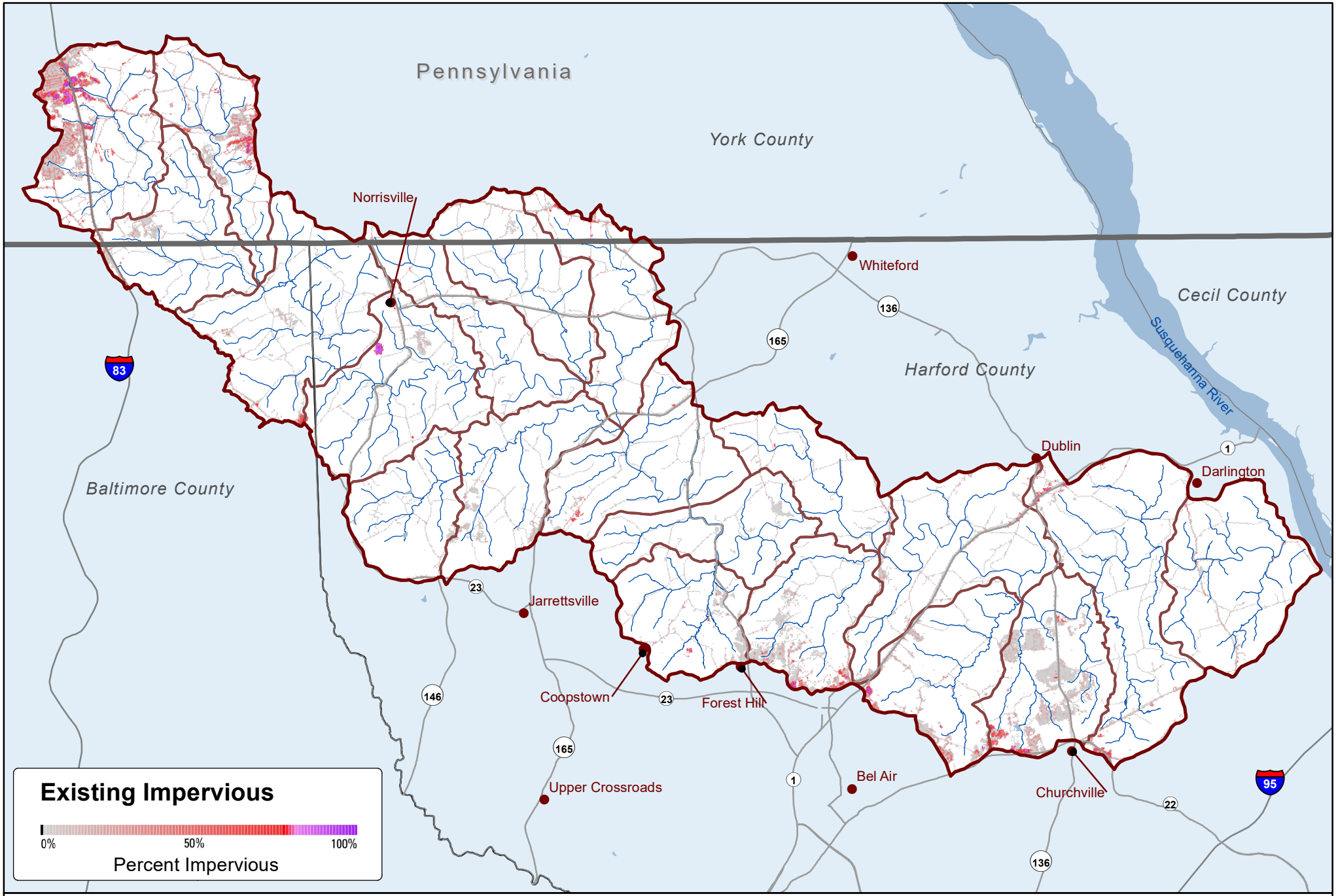
2.4.1 Imperviousness Methods

Impervious surface estimates were calculated for the watershed for characterization. Due to differences in impervious surface data sources, this impervious surface analysis should only be used for general information and not as a baseline imperviousness analysis. Impervious surface estimates for Harford County's portion of the watershed were calculated using Harford County's latest planimetric impervious surface GIS data from 2014. Impervious surface data from Baltimore County's portion of the watershed were calculated using the latest available planimetric impervious GIS data from 2014 from Baltimore County. A percent imperviousness was calculated for each Deer Creek subwatershed in Harford County.

Map 5 shows impervious surfaces throughout the Deer Creek watershed.

2.4.2 Results

Harford County's portion of the Deer Creek Watershed and subwatersheds have relatively low levels of impervious surface, which would be expected for a Watershed with a predominance of agriculture and forest use. Harford County's portion of the watershed has an overall existing imperviousness of 4.2 percent (see Map 6, below). Imperviousness is less than 5 percent in 14 of the 17 Harford County subwatersheds. Subwatersheds under 3 percent include Big Branch, Falling Branch, Island Branch, Lower Deer Creek, and Upper Deer Creek Plumtree. The Harford County subwatersheds with the highest level of imperviousness are Lower Deer Creek Tobacco Run Cool Branch (6.86%), Middle Deer Creek (6.44%), and Stout Bottle Cabbage Run (6.31%).



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Map 5: Existing Impervious

Table 6:Harford County Impervious Surface Summary

ID	Subwatershed	Existing Imp. Area (acres)	Ex. Imp. Percent
1	Big Branch	103.47	2.78
2	Falling Branch	106.67	2.81
3	Island Branch	111.40	2.81
4	Little Deer Creek Lower	195.95	3.81
5	Little Deer Creek Upper	133.88	3.45
6	Lower Deer Creek	177.70	2.75
7	Lower Deer Creek Mill Hopkins Hollands Graveyard	410.28	4.54
8	Lower Deer Creek Tobacco Run Cool Branch	369.17	6.86
9	Middle Deer Creek	258.42	6.44
10	Middle Deer Creek Kellogg	157.51	3.59
11	Middle Deer Creek Rock Hollow Wet Stone	241.50	4.15
12	Middle Deer Creek St. Omar	303.56	4.26
13	Stirrup Run	179.98	4.29
14	Stout Bottle Cabbage Run	293.48	6.31
15	Thomas Run	282.48	5.34
19	Upper Deer Creek Jackson Branch	197.82	3.04
20	Upper Deer Creek Plumtree	57.20	2.17

3 Candidate Sites

Candidate sites are specific areas needing restorative action. They were derived from several data sources and fit three different categories; tree planting, stream restoration, and stormwater management. Due to the urban sector focus of this watershed assessment, agricultural BMP specific candidate sites were not targeted during the assessment.

3.1 Methods

Candidate sites were selected from a desktop GIS analysis. The desktop analysis used readily available GIS data from Harford County, the Maryland iMap GIS data repository, aerial photography from the United States Department of Agriculture's National Agriculture Imagery Program, and basemaps from ESRI.

3.1.1 Tree Planting Sites

Tree planting sites were selected from all Harford County owned properties within the Deer Creek watershed. Privately owned properties were not considered for potential planting sites. County-owned properties were visually assessed using available aerial photography for planting opportunities. Planting opportunities were first targeted for minimal or unforested stream buffers on County property. There were few County-owned stream buffer planting opportunities identified so the visual assessment was broadened to include any unforested areas on County-owned property. Sites which appeared to be used for active recreation were excluded. Properties with unforested areas were selected and the area without trees was delineated for planting. Potential sites with a planting area less than 2 acres were removed from consideration. The desktop analysis resulted in 13 potential planting locations totaling 152.7 acres (Map 6). Field investigation of these proposed sites will be necessary to determine the feasibility of tree planting. Several of the identified potential tree planting sites appear from the aerial photography to be currently used for agriculture. Converting these properties to forest will help the County move toward meeting its mandated Chesapeake Bay goals.

3.1.2 Stream Restoration sites

Stream restoration sites were selected for field evaluation from the desktop analysis. The desktop analysis identified road crossings on streams not previously assessed during the Deer Creek WRAS (KCI, 2007). Stream sites were selected so that most of the tributaries to Deer Creek had at least one assessed reach from either the WRAS of this assessment effort. Direct-drainage first order tributaries were not considered for this field effort. Candidate sites were then visited in the field and assessed for possible stream restoration. Sites were assessed for bank erosion severity and extent, for the ease of access by construction equipment, and for the likely success of the project.

Sixteen candidate sites were visited in the field with four of those candidate sites determined to be good potential project sites (Map 7). Those four potential projects total 7,975 linear feet of stream restoration.

3.1.3 Stormwater Management

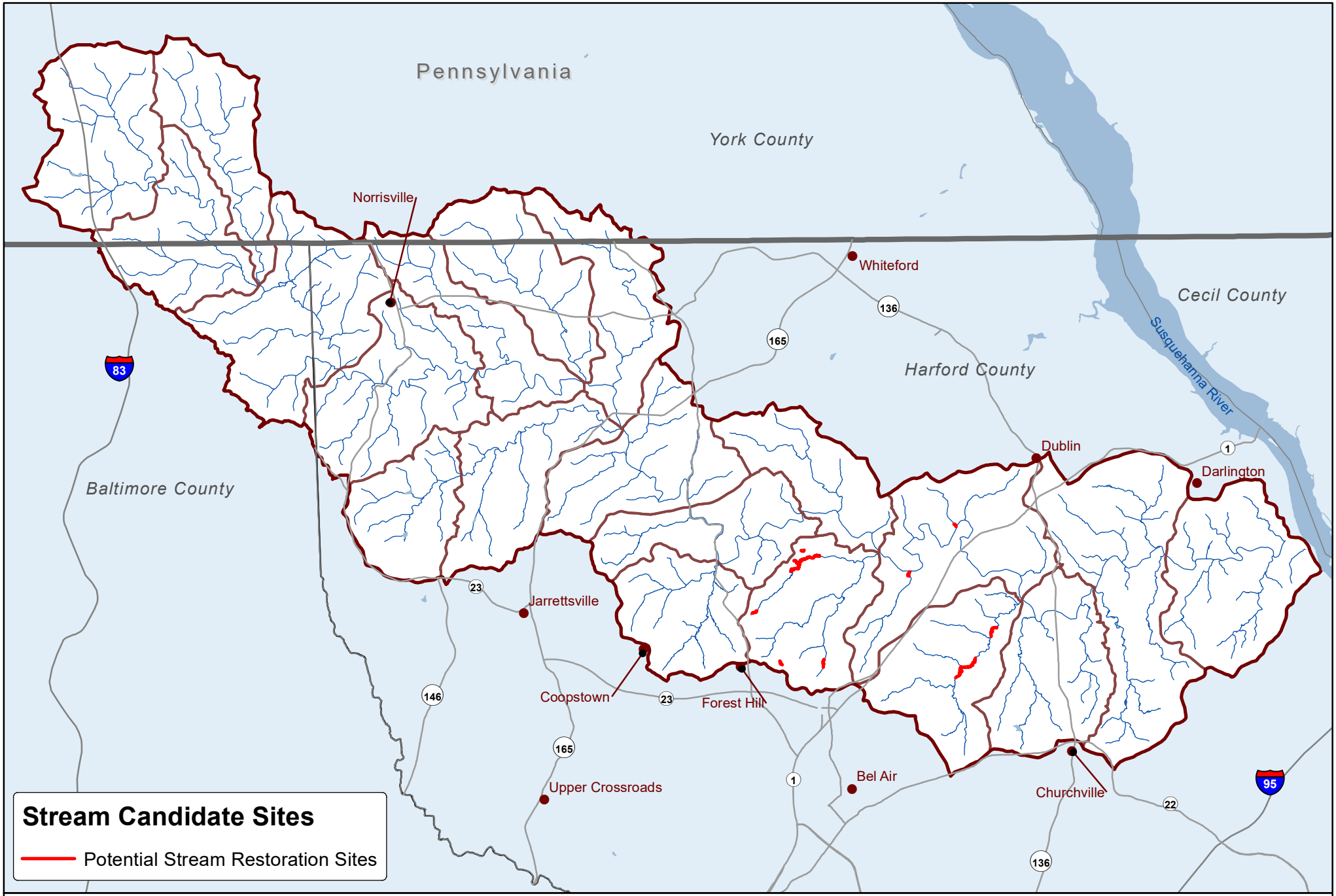
Sites for possible stormwater management projects were identified from the desktop analysis. Candidate sites were selected from the County's subdivision GIS data and from the approximate age of the development from tax records. The desktop analysis targeted subdivisions that were built prior to stormwater management requirements (pre-1985) or built prior to 2002 and assumed to have stormwater management without full water quality treatment. Subdivisions were selected for field site visits to determine the feasibility of project implementation. While visiting candidate sites, neighborhoods were also assessed for the installation of rain gardens and rain barrels. The field crew filled out the Center for Watershed Protection's Neighborhood Source Assessment field sheets (CWA, 2004) for each neighborhood or subdivision visited during the field effort. Neighborhood source assessments were completed for four subdivisions and three of these subdivisions are candidates for rain garden and rain barrel treatments. Projects from the Stout Bottle Branch/Cabbage Run Subwatershed Action Plan report (KCI, 2012) were added to the list of possible projects from the site visits. A total of five stormwater retrofit projects are identified treating a total of 21.65 acres of impervious surface. Two outfall stabilization projects using step pool stormwater conveyance are identified which treat a total of 2.88 acres of impervious surface.

3.1.4 Wetland Restoration Sites

Two wetland restoration sites recommended in the Stout Bottle Branch/Cabbage Run Subwatershed Action Plan report (KCI 2012) were included in this assessment. Details of the wetland restoration projects may be found in the Stout Bottle Branch/Cabbage Run Subwatershed Action Plan.

DEER CREEK
Watershed Assessment

Map 6: Potential Tree Planting Sites



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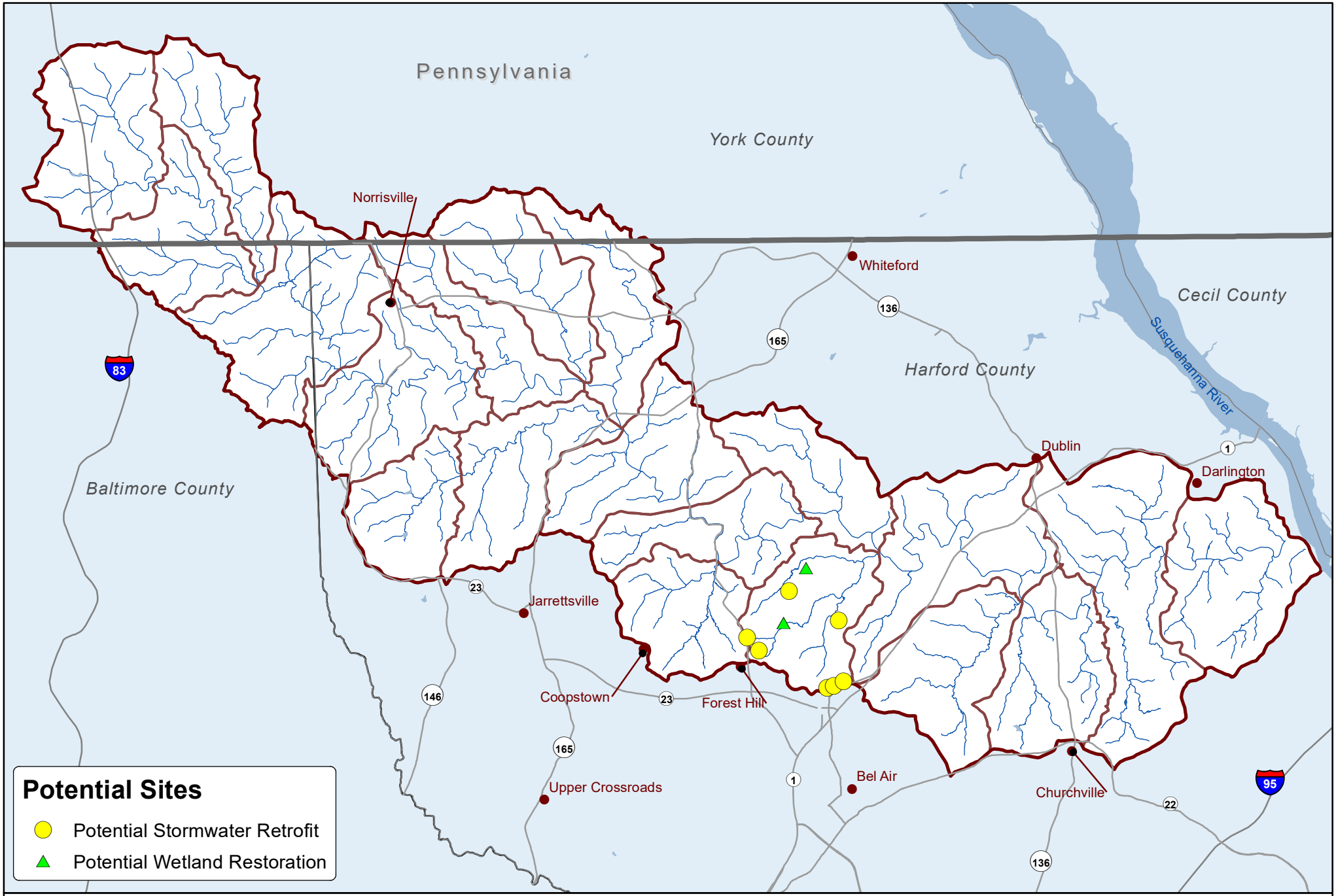
Map 7: Potential Stream Restoration Sites



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Map 8: Potential Stormwater and Wetland Sites

3.2 Modeled Reductions

Pollutant load reductions were modeled for the identified potential projects from the 2017 field effort. Modeling methodology and results are provided in the sections below.

3.2.1 Methods

Pollutant reductions for structural stormwater management practices and homeowner practices (i.e., rain barrels and rain gardens) were modeled using revised removal rate curve equations for runoff reduction (RR) and stormwater treatment (ST) practices prepared by Chesapeake Stormwater Network (Schueler and Lane, 2015). Reductions are calculated based on rainfall treatment, whether noted in project concepts or as an assumption of 1-inch treatment, and removal efficiencies per RR and ST practice (Table 7). The pollutant removal from homeowner practices was calculated based on the area of treated rooftop impervious in relation to associated total rain treatment from rain barrel capacity and average size and volume of rain gardens.

Table 7: Runoff Reduction and Stormwater Treatment Practices Removal Rate Reductions

Practice	Rainfall Treatment	Nitrogen Reduction	Phosphorus Reduction	Sediment Reduction
Runoff Reduction (RR)	1”	60%	70%	75%
Stormwater Treatment (ST)	1”	35%	55%	70%

Load reductions for stream restoration projects were calculated for total nitrogen, total phosphorus, and total suspended sediment for each restoration site with estimated removal efficiencies from *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (MDE, 2014).

Load reductions for tree planting projects were calculated for total nitrogen, total phosphorus, and total suspended sediment for the site with estimated removal efficiencies from *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated* (Table 8; MDE, 2014). These efficiencies assume a survival rate of 100 trees/acre or greater with at least 50% of trees having a two inch diameter or greater (4.5 feet above ground; MDE, 2014).

3.2.2 Results

The results of the modeling exercise are presented in Table 8, Table 9, and Table 10. Implementation of all potential projects will result in a reduction of 3,135.7 TN EOS lbs/yr, 1,275.7 TP EOS lbs/yr, and 867,181.4 TSS EOS lbs/yr.

Table 8: Load Reductions from Proposed Stormwater BMPs

						Load Reduction		
Site Name	**Proposed BMP Type**	**Drainage Area (ac)**	**Pervious Area (ac)**	**Impervious Area (ac)**	**Length (lf)**	**TN-EOS lbs**	**TP-EOS lbs**	**TSS-EOS lbs**
R1	SWM Retrofit	15.0	12.9	2.1		73.2	4.1	5,327.1
R2	SWM Retrofit	22.9	20.5	2.4		111.1	5.7	7,289.0
R3	SWM Retrofit	17.0	10.6	6.4		89.2	7.5	10,560.8
R4	SWM Retrofit	11.6	6.9	4.6		61.2	5.3	7,535.6
R5	SWM Retrofit	10.1	4.0	6.1		56.6	6.1	8,901.1
WR1	Wetland Restoration	2.1	2.1	0.0		9.9	0.4	414.6
WR2	Wetland Restoration	0.5	0.5	0.0		2.3	0.1	98.7
OS1	SPSC	6.1	4.2	1.9	140.0	31.5	2.4	3,389.7
OS2	SPSC	3.3	2.3	1.0	260.0	16.6	1.3	1,716.4
ST1	Stream Restoration				2,050.0	153.8	139.4	92,250.0
ST2	Stream Restoration				450.0	33.8	30.6	20,250.0
ST3	Stream Restoration				4,795.0	359.6	326.1	215,775.0
ST4	Stream Restoration				550.0	41.3	37.4	24,750.0
ST5	Stream Restoration				1,200.0	90.0	81.6	54,000.0
ST6	Stream Restoration				700.0	52.5	47.6	31,500.0
Thomas Run A	Stream Restoration				1,850.0	138.8	125.8	83,250.0
Thomas Run B	Stream Restoration				4,920.0	369.0	334.6	221,400.0
Walters Mill UT	Stream Restoration				755.0	56.6	51.3	33,975.0
Sandy Hook UT	Stream Restoration				450.0	33.8	30.6	20,250.0
Aldino Rd County Property	Tree Planting	19.7	19.7			174.3	4.8	3,171.2
Darlington Rt1 Park-and-Ride	Tree Planting	6.3	6.3			55.8	1.5	1,014.1
Dublin County Property A	Tree Planting	10.0	10.0			88.5	2.5	1,609.7
Dublin County Property B	Tree Planting	2.2	2.2			19.5	0.5	354.1
Dublin County Property C	Tree Planting	11.9	11.9			105.3	2.9	1,915.6
Dublin County Property D	Tree Planting	10.3	10.3			91.1	2.5	1,658.0
Scarboro	Tree Planting	18.3	18.3			161.9	4.5	2,945.8
Rt1 Re-Planting	Tree Planting	4.7	4.7			41.6	1.2	756.6
Sandy Hook	Tree Planting	30.5	30.5			269.9	7.4	4,909.7
Walters Mill	Tree Planting	2.7	2.7			23.9	0.7	434.6
Eden Mill Hilltop	Tree Planting	3.0	3.0			26.5	0.7	482.9
Eden Mill Big Branch	Tree Planting	2.1	2.1			18.6	0.5	338.1
Norrisville Rec	Tree Planting	30.8	30.8			272.5	7.5	4,958.0
Total		**241.1**	**216.5**	**24.5**	**18,120.0**	**3,130.0**	**1,275.1**	**867,181.4**

Table 9: Load Reductions from Proposed Rain Barrels

Neighborhood	# of Homes	Avg. Roof Area to Treat (sq ft) for 50% of Total Area	Rainfall Depth Treated	% Removal Based on Total Rain Treatment		# of Homes Participating	# of Rain Barrels per Neighborhood	Load Reduction per Neighborhood	
				TN	TP			TN – EOS lbs	TP – EOS lbs
Campus Hills Estates	63	1,221	0.14	17%	21%	10	20	0.9	0.1
Woodshire Village	16	1,624	0.11	13%	16%	2	4	0.2	0.0
Timber Ridge Estates	15	1,555	0.11	14%	16%	2	4	0.2	0.0
Total								1.2	0.1

Table 10: Load Reductions from Proposed Rain Gardens

Neighborhood	# of Homes	Avg. Roof Area to Treat (sq ft) for 50% of Total Area	Rainfall Depth Treated	% Removal Based on Total Rain Treatment		# of Homes Participating	Load Reduction per Neighborhood	
				TN	TP		TN – EOS lbs	TP – EOS lbs
Campus Hills Estates	63	1,221	1.00	60%	70%	10	3.0	0.3
Woodshire Village	16	1,624	1.00	60%	70%	2	0.8	0.1
Timber Ridge Estates	15	1,555	1.00	60%	70%	2	0.8	0.1
Total							4.5	0.5

4 Conclusion

This Deer Creek Watershed Assessment has identified potential projects to benefit water quality in the watershed and help Harford County make progress towards its mandated Chesapeake Bay obligations. Implementation of these projects would reduce nitrogen by 3,135.7 lbs/yr, phosphorus by 1,275.7 lbs/yr, and sediment by 867,181.4 lbs/yr.

The recommendations in this plan are based on the results of previous studies, The 2007 Deer Creek WRAS, a 2017 field effort, and desktop watershed analysis. The synthesis of the available information indicates that the Deer Creek watershed requires both restorative actions and strategies to protect its high levels of biodiversity and sensitive natural resources. The Deer Creek Watershed will face many challenges including potential rapid growth in the headwaters and the continued loss of agriculture and forest resources.

The watershed assessment should be reevaluated at regular intervals to assess progress from project implementation and changes due to further land use conversion. This watershed assessment represents the current understanding of the overall condition and stressors to the watershed. As lessons are learned from the implementation of projects in surrounding watersheds, those lessons may prove useful to refine and update this assessment.

Restoration and protection of the Deer Creek Watershed will require a committed and coordinated effort from community groups, the public, and resource managers at all levels of government in Harford, Baltimore and York Counties with support and technical assistance from State and federal agencies.

5 References

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Scope of Work for Proposed Assessment for Upper Bynum Run

Stantec

Attachment A - Scope of Work
Upper Bynum Run Small Watershed Assessment
March 22, 2017

Stantec proposes the following scope of services to prepare a Small Watershed Assessment for the Upper Bynum Run Watershed. Based on coordination with the County, we understand that the study area will include the portion of the overall Bynum Run watershed located just north of East West Highway (MD Route 23) and extend to an area just upstream of the Route 22 bridge. As directed by the County, the town of Bel Air will be included in the overall assessment area. Stantec will evaluate the current watershed and water quality conditions; identify and prioritize projects and management actions within the watershed; estimate impervious acres treated; and prepare applicable documentation to clearly convey the results of the study in both a full technical as well as a summary report. Stantec will complete the assessment and plan in accordance with the following tasks.

1. Data acquisition and Review
    a. Under this task, Stantec will acquire, review, and analyze existing watershed data including: historical/aerial mapping and photography; available utility mapping; as-built plans; biological, physical and water quality data; FEMA regulated boundaries; soils and geologic data; and where available, conceptual design reports for each site. It is assumed that Harford County will provide the following data in GIS format as available:
        1. Land use/land cover
        2. Soils
        3. Impervious cover
        4. Existing and planned BMPs
        5. Existing and planned stream restoration reaches
        6. Property boundaries/ownership
        7. Forest cover/Natural Resources
        8. Proposed/planned land development
        9. County drainage assets including outfalls, storm drains, and streams
        10. 2' contours

        In addition, Stantec will obtain the following data from sources listed below for use in the existing conditions review.
        1. Wetlands (obtained from DNR or others)
        2. Existing monitoring data (obtained from MBSS, USGS or others)
        3. Utilities (obtained from town or other jurisdictions)

    b. Stantec will use the provided GIS data to delineate sub-watersheds and identify sub-watershed characteristics

2. Existing Stormwater BMP Desktop Assessment – Under this task, Stantec will evaluate up to 196 existing BMP's focusing on the pre-2002 (94 pre-2002 and 9 undated) facilities and their retrofit potential.
    a. Stantec will obtain and review all available as-built data from Harford County.
    b. Stantec will use the as-built data and GIS information to compute existing treatment credits.
    c. Stantec will initiate the delineation of individual BMP drainage areas and determine land use to develop hydrology information.
    d. Stantec will compute existing pollutant loading/removal using *Bayfast*.

3. Stream Assessment

    a. Windshield Surveys - Stantec will perform windshield surveys for up to 60 miles of stream. Note that this number is based on available GIS data associated with ditches and streams. The data to be confirmed via windshield surveys is land use/land cover, roadway and access data, forest and natural resource coverage and limits, outfall locations, and other information that may be noted in the field. This process will involve locating specific pollution sources and hotspots and identifying reaches to be included in the Stream Corridor Assessments outlined below. From the windshield surveys, Stantec will develop a site area layer that will be provided to Harford County to verify its mailing list for property owner notifications regarding field access. We understand that the County will obtain approvals and will provide Stantec field crews with a carry letter as necessary.

    b. Stream Corridor Assessments - Based on the results of the windshield surveys, Stantec will evaluate up to 30 miles of streams using standard SCA protocols as outlined in *Stream Corridor Assessment Survey: SCA Survey Protocols* (MDNR, 2001). Only public properties and private properties for which property owners specifically granted permission will be assessed. The field investigations will consist of a two-person team walking the stream channel and conducting a visual assessment to locate problem areas and assess their severity and correctability. Field teams will collect information on channel alteration, erosion, exposed utility pipes, drainage pipe outfalls, fish barriers, inadequate buffers, construction in or near the stream, trash dumping, and unusual conditions. Locations of the above information will be recorded using GPS. Throughout the study area, Stantec will select representative stream segments and assess the general physical habitat condition using a modified version of the EPA's *Rapid Bioassessment Protocols* (Barbour et al., 1999). The assessment will include qualitative

ratings for ten habitat parameters as well as information on wetted width, pool, run, and riffle depths, and channel substrate.

c. Analysis and Mapping - Stantec will analyze the assessment data to identify reaches recommended for further investigation. We will prepare mapping showing the areas assessed and field conditions, highlighting areas of moderate and severe erosion. Unstable reaches will be identified and potential causes and remedies for degradation will be discussed in the letter report outlined below. As noted in Section 2.d the overall existing pollutant loading will be calculated using *Bayfast*. Load reductions will be calculated through the incorporation of BMPs and stream restoration projects during the next phase of the project.

4. Letter Report
   a. Under this task, Stantec will develop a letter report based on the results of the desktop/GIS analysis and field investigations. The Report will include the following sections:

      1. Watershed Characteristics including land use/land cover, soils, impervious cover, TMDL status
      2. Sub-drainage area maps
      3. Existing BMP inventory and retrofit potential including prioritization
      4. Existing monitoring data (as available from MBSS, USGS etc.)
      5. Existing watershed pollutant load calculations including a description of methodology used
      6. Stream Corridor Assessment results, including reaches recommended for further investigation

   b. Report Submittal - Stantec will submit the Letter Report to Harford County for review in electronic format.

   c. Report Revisions – Upon receipt of County comments, Stantec will revise the report and resubmit the documents to the County for final approval. Stantec assumes one round of revisions.

      Meeting – Once the Letter Report is finalized and approved by the County, Stantec will meet with the County to discuss the overall existing conditions and opportunities in the watershed. This discussion will start with a "master list" of existing BMPs and potential restoration practices that warrant further investigation. From this meeting, Stantec and the County will agree upon which opportunities should be further developed in the SWAP.

5. New/Retrofit BMP Site Search and Analysis
    a. Under this Task, Stantec will conduct a GIS-based desktop search focusing on identifying non-forested pervious surfaces within the watershed that could be utilized for new stormwater treatment BMPs. The geodatabase will be updated to reflect the areas identified as potential restoration opportunities. The areas will be prioritized for field visits. Stantec will develop a site area layer that will be provided to Harford County to develop a mailing list for property owner notifications to obtain field access. Stantec understands that the County will obtain approvals and will provide Stantec field crews with a carry letter.

    b. Stantec will conduct site visits for approximately 50 BMPs (new), 94 pre-2002 facilities and 9 undated facilities, to verify suitability for retrofit or new BMPs. The new BMPs may consist of structural (ponds, constructed wetlands, rain gardens, sand filters, etc.) or non-structural (swales, pavement removal, rooftop disconnect, etc.) practices. Stantec will rank the sites based on the collected data and review with Harford County to select the top sites.
    c. For the top rated sites, (no more than 100 BMPs), Stantec will perform the following:
        1. Hydrologic computations, including drainage area delineation, hydrologic soil group determination/verification, land use verification, runoff curve number (RCN) determination, time of concentration determination, and TR-55 analyses will be completed for each proposed BMP.
        2. BMP type selection and general sizing will be based on the following:
            a. minimizing impacts to right-of-way and natural resources
            b. avoiding impacts to utilities
            c. adherence to MDE's Accounting for Stormwater Wasteload Allocations and Impervious Treated
            d. potential needed modifications to the existing drainage system(s)
            e. adjacent land use
            f. BMP maintenance needs
            g. ability to outfall an underdrain system
        3. Pollutant load reduction & Impervious area treatment computations based on contributing drainage area characteristics, BMP type/sizing, and BMP pollutant removal efficiencies.
        4. Construction/Design Cost estimates

6. Proposed Stream Restoration Analysis

Under this Task, Stantec will develop pre-conceptual plans, pollutant load reduction estimates, and cost estimates for up to five miles of stream in accordance with the following activities.

a. Stream Assessment - Under this sub-task, Stantec will build upon the fieldwalk conducted during the stream corridor assessment. We will conduct a geomorphic assessment that includes cross sections and BEHI evaluations for reaches within the study area. In addition, stream classification, sinuosity, width/depth ratio, reach slope and other pertinent information will be determined. For budgeting purposes, we have estimated up to 1,000 linear feet of assessment per mile of conceptual plan development. Reaches will be selected that best represent overall existing conditions.
b. Conceptual Designs (10% level). Stantec will develop conceptual designs for up to five miles of stream. The concepts will include 11x17 inch aerial photos with project details such as treatment options, potential access, site constraints, proposed alignments, etc.
c. Pollutant Load Reduction Estimates - Under this sub-task, Stantec will estimate pollutant load reductions and impervious acres treated. The 2014 "*Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects*" includes a summary of studies completed to assign a nutrient and sediment removal rate per linear foot of stream restoration in Maryland. The report notes that while it is not appropriate to assign similar pollutant load removal rates to implemented stream restoration efforts, these general rates should inform planning purposes. To develop an estimation of the TMDL credit generated for each potential project (based on pollutant removal) the revised default rate will be applied. A value of lb/ft/yr of Total Nitrogen (TN), Total Phosphorous (TP), and Total Suspended Solids (TSS) will be provided for each potential project being evaluated for stream restoration based on the linear footage of the proposed project.
d. Construction/Design Cost estimates. Based on the 10% level conceptual design, Stantec will develop design and construction cost estimates for the County's use in future project planning.

7. Small Watershed Assessment Report -Stantec will prepare a Small Watershed Assessment Report following 319 criteria (a-i) that contains the following sections:
   a. Executive Summary
   b. Watershed Characteristics (from Letter Report)
   c. Sub-drainage area maps (from Letter Report
   d. Existing monitoring data (from Letter Report)
   e. Existing BMP inventory (from Letter Report)

f. Field reconnaissance including photo documentation
g. Inventory of potential BMP sites and/or stream restoration sites
h. Proposed BMP (retrofit and new) projects, no more than 100
    1. BMP description
    2. Estimated pollutant load reduction and impervious acres treated
        a. BMP pollutant removal will be calculated based on Maryland approved efficiency rates for each practice, practice size, and impervious drainage area served.
    3. Site constraints
    4. Cost estimate for design and construction
    5. Cost/benefit analysis
i. Proposed stream restoration projects, no more than five miles
    1. Description
    2. Estimated pollutant load reduction and impervious acres treated
        a. See Section 6.c above for estimation methodologies.
    3. Site constraints
    4. Cost estimate for design and construction
    5. Cost / benefit analysis
j. Implementation Schedule
k. Proposed monitoring programs
l. Proposed outreach program
m. Summary
    1. Narrative for recommendations
    2. Tables of prioritized projects including costs and benefit
n. Report Submittal - Stantec will submit the Report to the County for review in electronic format.
o. Report Revisions – Upon receipt of County comments, Stantec will revise the report and resubmit the documents to the County for final approval. Stantec assumes one round of revisions.

8. Meetings

a. Kick-off Meeting - Within two weeks of the notice to proceed, Stantec will schedule a kickoff meeting to be held at the County offices. The project manager and key personnel will attend. The purpose of the meeting is to discuss the scope of work, schedule, and necessary background information to initiate the project. Stantec will submit a written schedule outlining the milestones for the SWAP and projected dates for submittals to the County. Stantec will prepare meeting notes and distribute the notes to all attendees no later than one week after the kickoff meeting.

b. Progress Meetings - Monthly progress meetings will be held via conference call to discuss the status of the project including any changes to the project schedule.

Stantec will prepare meeting notes and distribute the notes to all attendees no later than one week after the monthly progress meeting.

c. Stantec will attend up to three additional milestone meetings with the County.

d. Public Meeting Support - Stantec will develop the following to assist the county in presenting the findings of the assessment and potential restoration projects to the public with a goal of engaging and developing public awareness/support for future projects:

   i. Summary of the results tailored to public consumption, using simplified language, and easily understood presentation of the results.
   ii. An online presentation of the project using ESRI Story Maps features that will be able to present project findings and proposed solutions to the County and residents if the County wishes to share the internet link with the public.
   iii. Powerpoint Presentation suitable for presentation at a public meeting.
   iv. Stantec will attend and support the presentation of the project and its findings at one public meeting. The County will decide the appropriate audience and presentation format.

16-158, Task 1: Upper Byram Run Watershed Assessment (1-12-2017) - Attachment B

Tasks	Principal	Project Manager	Sr. Water Resource Engineer	Water Resources Engineer	Sr. Civil Engineer	Civil Engineer	Sr. Natural Resources Specialist	Natural Resources Specialist	Prof. Landscape Architect	Landscape Designer	CADD/GIS Technical	Prof. Land Surveyor	Clerical	Total Hours	Cost
Contract Rate	237.02	169.07	151.01	98.91	171.54	92.16	153.55	82.03	105.10	88.48	90.89	142.54	58.00		
1. Data Acquisition and Review															
a. Obtain GIS Data		2		4							6			12	1,279.12
b. Delineate subwatersheds and subwatershed characteristics			2	16							2			20	2,066.36
2. Existing Stormwater BMP Assessment – 196 BMPs															
a. Obtain and review documentation		4	24											28	4,300.52
b. Compute existing treatment credits		10	40	196										246	27,117.46
c. Existing conditions hydrologic analysis		3	8	60										71	7,649.89
d. Compute existing pollutant removal loading using Bayfast		4	49	98										151	17,768.95
e. Internal QA/QC of Ex. BMP Assessment	1		4		16									21	3,585.70
3. Stream Assessment															
a. Windshield Surveys			8	64				72						144	13,444.48
b. Perform stream corridor assessment (up to 30 miles)			24	120				120						264	25,337.04
c. Analyze assessment data and prepare mapping (Note that overall pollutant loads will be calcuated under previous task)			16	40				40			40			136	13,289.36
d. Internal QA/QC of Stream Assessment	1	4	4	16										25	3,099.90
4. Prepare Letter Report														0	-
a. Prepare Report and Figures		8	16	60			8	32			32		6	162	16,813.16
b. Internal QA/QC of Letter Report	2		4				4							10	1,692.28
c. Revise and re-submit Letter Report per County review commen	1	4	8	16			4	8			4		2	47	5,453.94
5. New/Retrofit BMP Site Search and Analysis															
a. Desktop analysis		2	8	32							4			46	5,074.90
b. Field reconnaissance		8	40	120				80			20			268	27,642.36
c. Proposed BMP treatment analysis		4	24	60							8			96	10,962.24
Proposed condition hydrologic analysis		2	12	36										50	5,711.02
Proposed BMP cost estimate		2	4	24										30	3,316.02
Proposed BMP pollutant load reduction		4	12	60										76	8,423.00
Internal QA/QC of BMP Site Search	1		4			12								17	1,946.98
6. Proposed Stream Restoration Analysis															-
a. Detailed Stream Assessment and Analysis (Up to five miles)				96			80								21,779.36
b. Develop pre-conceptual design recommendations with detailed assessment		4	40	60				24			24			152	16,801.36
c. Pollutant load reduction and TMDL treatment estimates			8	16							16			40	4,244.88
d. Proposed stream restoration cost estimate			16	24							16			56	6,244.24
Internal QA/QC of proposed stream restoration analysis	2	4	4	8							4			22	2,909.20
7. Small Watershed Assessment Report															
Develop implementation schedule		2	6	10										18	2,233.30
Evaluate permitting needs							4							4	614.20
Prepare report		12	24	60			36	12			16		16	176	20,482.08
Internal QA/QC of Assessment Report	4		4			10	4							22	3,087.92
Revise and re-submit Assessment Report per County review cor	1	4	8	24			4	8			4		2	55	6,245.22
8. Meetings															
a. Kickoff Meeting	2	6	4	4			4							20	3,102.34
b. Monthly Progress Conference Calls - 10	5	20		10			10							45	7,091.10
c. Additional Meeting 1 - Existing Conditions Meeting	2	8	4	4			4							22	3,440.48
Additional Meeting 2 - Preliminary Assessment Review Meeti	2	8	4	4			4							22	3,440.48
Additional Meeting 3 - Final Assessment Meeting	2	8	4	4			4							22	3,440.48
d. Public Outreach and Meeting Support															
i. Project Summary	2	4	8	12			4				4		8	42	4,987.08
ii. ESRI Story Map		4	8	12			4				24			52	5,866.84
iii. Powerpoint Presentation	1	4	4	8			4	8			4			33	3,942.62
iv. Preparation and attendance		12		16			16				8			52	6,795.32
Total Labor Costs	29	161	457	1394	16	22	198	404	0	0	236	0	34	2775	$ 332,723.18

Direct Costs	Unit Cost	Units	Total
Mileage	$ 0.535	5000	$ 2,675.00
Reproduction	$ 2,500.00	1	$ 2,500.00

Total Direct Cost $ 5,175.00

Total Labor	$ 332,723.18
Direct Costs	$ 5,175.00
Total Project Cost	$ 337,898.18